DISCOVERY

NOVEMBER 1957 2/6

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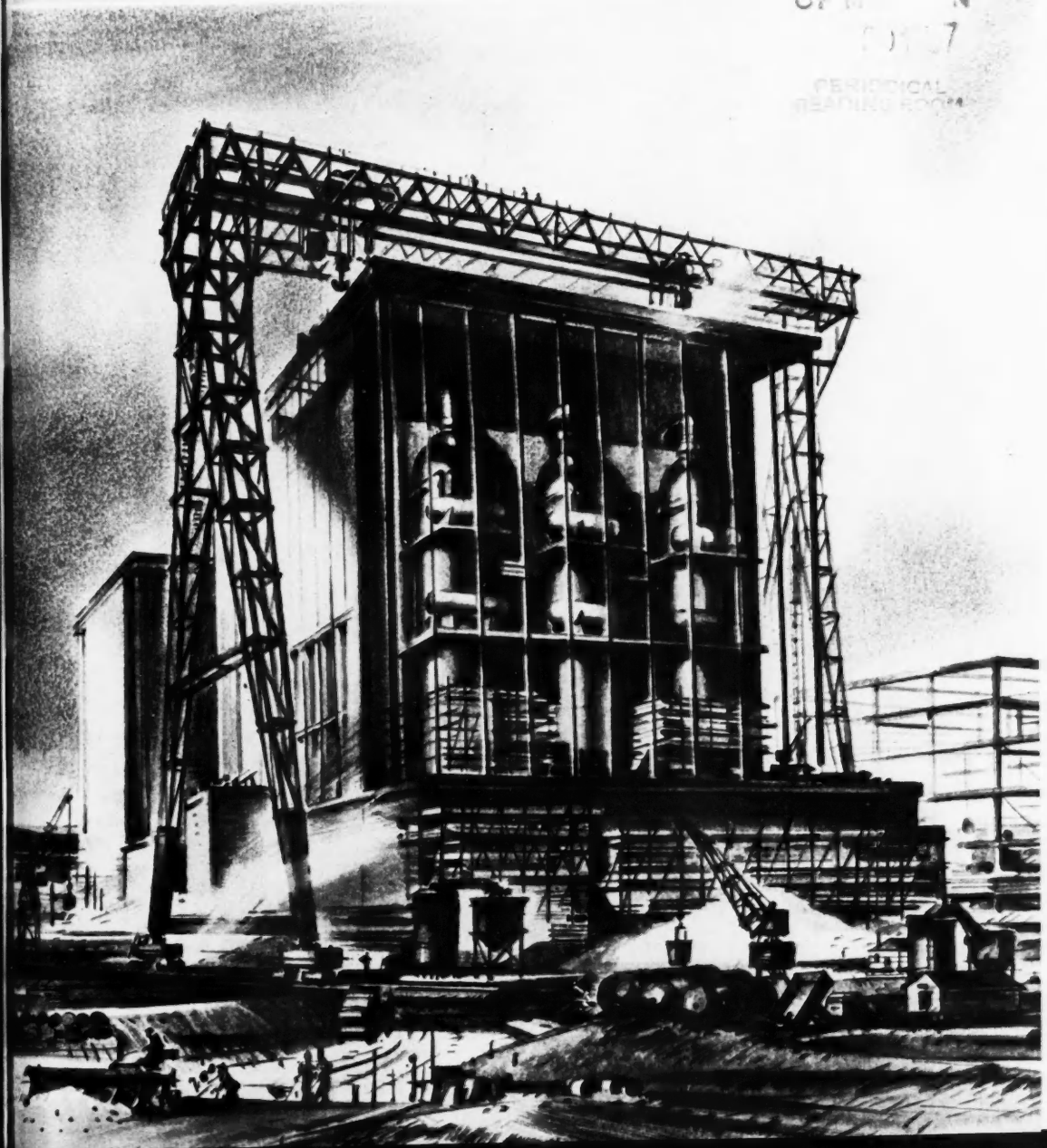

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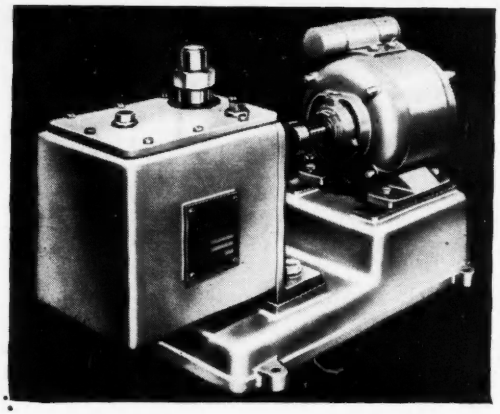

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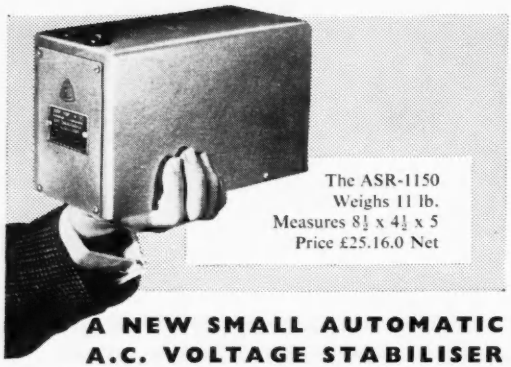

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COVER PICTURE: Our cover this month shows the giant crane which will be used during the erection of Hinkley Point Atomic Power Station. A description is given in the "Progress of Science" column, p. 454.

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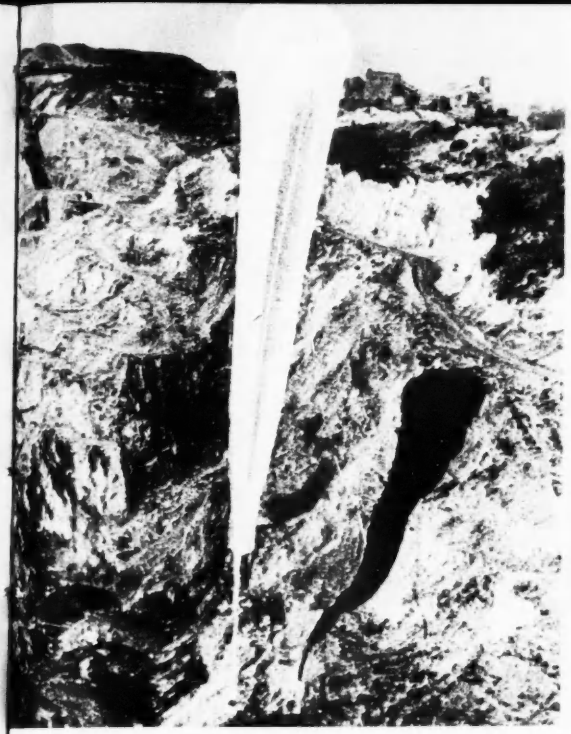


The balloon carrying Major David G. Simons taking off from an abandoned iron mine shaft near Minneapolis, Minnesota. The mile-long pit, 450 feet deep, was used for the launching to prevent surface winds from tearing the balloon's delicate polythene fabric. The plastic bag, 280 feet long at take-off, swelled out to about 200 feet in diameter at maximum altitude.

Major Simons sitting in the gondola prior to take-off on his balloon flight. The aluminium capsule, only 3 feet in diameter and 8 feet high, contains devices for maintaining pressure, carrying off moisture, and providing for the passenger in addition to scientific instruments for recording flight data. (*U.S. Navy Photographs.*)

THE PROGRESS OF SCIENCE

...AND A LITTLE LOWER THAN THE ANGELS

The report, in August of this year, of a balloon ascent by an American Air Force doctor, attracted considerable attention from newspaper, radio, and television reporters. The medical officer, David Simons, spent thirty-two hours in the gondola of a balloon which attained a maximum altitude of over 100,000 feet. For sixteen hours the height was in excess of 90,000 feet. From this height, it was reported, the curvature of the Earth was clearly visible.

There can be no question of the magnitude of this achievement. Although the gondola was pressurised and air-conditioned the pressure within it was certainly equivalent to an altitude greater than 25,000 feet, and decompression sickness was therefore an ever-present danger. Pre-flight breathing of pure oxygen, or of an oxygen-helium mixture, is known to reduce this hazard by washing out nitrogen from the tissues, but it would be rash to claim that pre-oxygenation could give absolute protection.

The temperature of the atmosphere at 100,000 feet is in the region of −20°C but the direct heat of the Sun raised the temperature of the inside wall of the cabin to 50°C. By night, the internal air temperature dropped to around freezing point, despite the efforts of the air-conditioning unit to maintain an equable 20°C.

Much has been written of the sense of loneliness which occurs at great heights, and fears have been expressed that "depersonalisation", with consequent loss of control, might develop. Thanks, perhaps, to constant and unremitting radio contact with the ground, Simons showed no evidence of this personality change, although he complained of the unearthly quiet.

As a scientific study, the flight is more difficult to assess. Very little of the information gained has been released, but it is fair to assume that with two possible exceptions most of it could have been obtained from experiments in a decompression chamber and from the launching of unmanned instrumented balloons. The effects of prolonged exposure to reduced barometric pressure, to extremes of temperature, and to complete isolation from sensory stimuli, for example, are being studied in various research units without access to balloons, and the science of telemetering information is already well advanced.

The subjective observations of the occupant could, however, only have been made during an actual ascent. The fact that the sky away from the Sun appeared totally black during the day was already known, but the apparent absence of stars or planets was an unexpected finding. Similarly, the observation that at one stage the setting Sun assumed a "purplish-blue blue" tint could not have been made from a decompression chamber, and no instrument could accurately record such abstractions.

The second, and more probable, scientific justification for the flight is to further the study of cosmic rays. This form of ionising radiation, which is of considerable biological importance, is hardly significant at the Earth's surface, but increases rapidly in intensity with altitude. At 75,000 feet the strength of the radiation is about 150 times that at sea-level. At still greater heights the total intensity falls somewhat, but the proportion of ionisation which is due to heavy particles rises steeply. The greater size of these heavy nuclei results in a larger zone of ionisation, while their greater speed imparts more kinetic energy to the electrons released from the atoms with which they collide. Thus, the biological effect of cosmic rays depends more upon the composition of the radiation than on its overall intensity, and at the present time the only readily available source of heavy nuclei is to be found at high altitudes. During the past few years, a wide variety of experimental animals has been dispatched by balloons and rockets to great heights for varying periods of time. Microscopical examination of their tissues has been used to detect the paths and effects of cosmic particles, and the genetic consequences of such irradiation have also been studied. However, it seems improbable that a similar programme is contemplated with man as the experimental animal, and Simons is said to have had photographic plates strapped to his body as a more useful means of recording the radiation.

The full report of the balloon ascent, and of the physical and physiological information gained from it, will be of great interest. It may not have proved, as some have claimed, that travel in outer space is safe, but at least it has provided first-hand evidence that the Earth is not flat.

WANTED: A SPACE LAW

It seems that a legal code for space travel cannot much longer be delayed. The International Geophysical Year has now presented us with the first true Earth satellite, and the intercontinental ballistic missile is ever reaching farther into outer space. Neither excursion would appear to be covered by existing air law.

In fact, the first serious attempt to look at the intercontinental ballistic missile from the international point of view was broached at the UN Disarmament Sub-Committee this summer when Mr Harold Stassen put forward on behalf of the United States a tentative plan to be linked with any partial disarmament agreement which might emerge. He proposed that all objects sent into "outer space" should be used only for scientific and peaceful purposes. This means that governments are already working on the general problem of the control of space travel.

Air law, as things stand today, developed from the extravagant claims of sovereign nations to exclusive rights above their territories up to the "sky" itself. A strip of sea outside their coasts has long been regarded by mutual consent among States as territorial water. When the aeroplane arrived, the doctrine of "territorial air", that is, the right of a nation to the air-space above it, was therefore taken for granted. Moreover, even apart from war-time considerations, governments had to protect their territories in peace-time from damage caused by aircraft coming or going, or anything that they might let fall in flight.

The International Air Convention at Chicago in 1944 laid down that every State has "complete and exclusive sovereignty over the air-space above its territory". But it says nothing about the space beyond the Earth's atmosphere. The basic difficulty here is that objects sent up into space cannot, because of the turning of the Earth, be confined to the space "above" any particular nation. And even if the fiction of national sovereignty over outer space were insisted upon as a legal right, will future satellites or space-ships have to be assured of the "right of innocent passage"? Such a right was accorded to civil aircraft by the signatory States of the 1919 Paris Convention for Aerial Navigation, and has already been modified out of existence by the 1944 Chicago Convention.

Governments will therefore have first to decide whether to seek international agreement on some temporary measure of "control" (whatever that may mean), as proposed by Mr Stassen, or begin to put in hand a comprehensive "space code" appropriate to the scientific realities of our age. One of these realities is that the space above a given sovereign territory is constantly changing. How indeed can an earthly government, however powerful, lay claim to any particular piece of space through which a space-ship might pass? In any event, the larger part of the Earth's surface is ocean and already outside the jurisdiction of national sovereignty, except for purposes which are limited by international agreement under, for example, maritime law or the regulations of ICAO (the International Civil Aviation Organisation). In short, extra-territorial rights make no sense at all in outer space, whatever governments or lawyers might say.

It is clear, therefore, that a revolutionary scientific factor has now arisen, and much study will be required before the ways of men can be adapted to it. But a few pointers may be tentatively suggested for dealing with these new dimensions of human travel and projectile movement. State sovereignty will have to terminate, legally, at some agreed and definite limit, say twenty (or even fifty) kilometres or miles above sea-level. State law and existing air law will doubtless continue to apply to the launching and landing stages of space-craft, while, beyond that limit, "freedom of space" will prevail. Within that new realm many human activities would require legal definition or sanction. For instance, local laws governing personal relationships inside and outside

the craft or between the craft and the outside "world" would need to be devised. As space-ships may be absent for months or years, space law would have to cover such things as contracts and wills and crimes, and much else. Inmates might die or, even, marry, and others might be born during space-flight.

For that, and for other reasons, thought is being seriously given as to whether the troublesome problem of so-called national sovereignty cannot be solved by vesting in the United Nations sole jurisdiction over outer space. It is difficult to envisage a comprehensive solution in any other context.

RESEARCH IN TECHNICAL COLLEGES

Ten years ago DISCOVERY (June 1947, p. 161) contained a note on the Ministry of Education circular 94, "Research in Technical Colleges". It stressed that, with 1080 hours per year demanded of each teacher as a minimum, the prospect for effective research was bleak. The establishment of the Colleges of Advanced Technology, however, ushers in a new era, and the time appears ripe for reassessment. Previously research has been an activity taking second place at all times to teaching, but in recent discussion with one of H.M. Inspectorate it was emphasised that the Ministry will *insist* that all colleges of advanced technology engage in research.

In a 1946 survey of fifty-seven major colleges, chosen to give favourable bias, only fifteen carried on an appreciable amount of research. A Midlands survey (1951) showed only six technical colleges believed to be engaged in research. Leading the provincial field was Birmingham College of Technology (Manchester and Glasgow must be omitted as forming part of the respective universities), with nine salaried research assistantships (Burnham scale) and seventeen full-time teaching staff on research work which was the direct responsibility of the deputy principal and was financed by college, industry, and *Admiralty*. The other five colleges contributed only two full-time research workers and showed only twenty teachers engaged in research.

The material reasons for the meagre contribution are:

(1) *Lack of facilities.* With new colleges and extensions "sprouting" all over the country it is sad to record that a number are known to be inadequate even before completion. Many lack the workshop provision necessary for effective research. The question has also been posed, "Will adequate, competent laboratory staff, having the time (and ability) to serve a research project, be forthcoming?"

(2) *Lack of research organisation.* Organisation of research from top level is seldom given the precedence it deserves. A head of department with heavy administrative and teaching responsibilities cannot be expected to guide research endeavours effectively, yet it is uncommon to appoint a research officer who has *official priority* allotted to his research activities, with teaching duties small and secondary. Here, as we saw, Birmingham pointed the way. It now goes a step further, for scanning of recent advertisements for senior staff discloses a demand for "ability to *originate* and guide research work", the important addition being the emphasis on "originate".

(3) *Lack of time among teaching staff.* Here it is appropriate to note that in some cases appointments have been made on a "teaching plus research" basis where class contact is reduced to twelve hours (subject to the staff member having published research findings and thus proved his ability)—a significant improvement upon the situation described in circular 94.

(4) *Lack of research contact with other groups.* With isolated exceptions, the outlook is grey. Approaches made to universities show that there is little interest in "part-time researches" even where the time available could offer prospect of fruitful result. (This is a generalisation—some universities do countenance such work to a limited extent.)

The ties between industrial and technical college research, although much strengthened, still fall far short of the ideal. Large sums of money, library facilities, laboratory equipment, and staff help to the technical colleges are much more common now than ever before. But the outstanding case of a teacher ambitious to engage in research being granted the use of an industrial laboratory of a well-known firm still provides an example of the liaison strength at which we must aim.

Perhaps the most significant advance is the innovation at Birmingham of "Sandwich Research Topics". Sandwich courses, which of recent years have become a fashionable part of technical college teaching, enable students to study full time for six months of the year and return to work for the other six months.

Application of sandwich course procedure to post-graduate (or post-diploma-of-technology) work, enables the fourth "year" of the sandwich course to be spent on a short research topic involving six months' full-time study. This means that nearly always the teaching staff must initiate the topic by direct suggestion; meantime the student is gaining insight into research method under adequate full-time guidance.

Enlightenment already shines in many places. From Crumlin comes work published by the principal and physics staff in concerted effort. At Bradford the award of a Ph.D. or M.Sc. marks continued research activity. In Manchester and Glasgow, university-technical college arrangements are fast becoming—as in London—"a law unto themselves", as G. M. Trevelyan said. Further inquiry shows that research work of a higher-degree standard has been published at several other technical colleges, for example at Salford, Wolverhampton and Rugby.

Quotations from DISCOVERY for June 1947 furnish our epilogue. We wrote then: "In a time of overall shortage of scientific manpower, the very many technical teachers with research potentialities form a hitherto unused reserve which should now be exploited to the full. They could play a specially important part in strengthening that weakest link in British science, the link between fundamental research and industrial application. Thus the smallness of the actual research contribution from technical colleges should cause grave concern, and

serious exertion to increase it is required." And later, "their effective contribution is so far short of the ideal".

I think we can now say that the "weakest link in British science", although still causing "grave concern", is the subject of more serious exertion in wider circles. Realisation of its potentialities is at last receiving its fair share of publicity and attention.

Circular 94 may yet escape the fate of being "thrown away as a mass of barren verbiage". We recommend that Ministry of Education Circulars Nos. 96, 255, and 283 should also be read, together with "The Education of Physicists in Universities and Colleges of Technology", an Institute of Physics publication, and "Technical Education", by P. F. R. Venables.

PLANETARY RADIATION

C. H. Barrow and T. D. Carr, Department of Physics, University of Florida, Gainesville, Florida, have a paper with the above title in *The Journal of the British Astronomical Association* for July 1957, vol. 67, in which they describe the results of their investigations of radiation from different sources, using a radio interferometer. This consists of two double collinear arrays separated by ten wavelengths, each array consisting of eight half-wave dipoles. One array was completed at the end of August 1956 and has been operating independently since, pending completion of the second array. A number of figures explain the main principles of the apparatus and readers who are interested in these can easily follow the details of the working of the single array: it will suffice to outline the results so far obtained.

Dealing first with the background noise of the galaxy, it was found that this normally shows a maximum intensity as the Milky Way passes through the reception beam, and this was observed when the array was first used. The maximum became less pronounced later in the year and began to occur in the early morning hours rather than at sunset when the Milky Way was overhead. Some interesting deductions were made for a typical period in October 1956 from the intensity variations, plotted against time and shown in a figure. The curves indicate an increasing opacity of the ionosphere, due to the approach of the sunspot maximum, a small portion only of the radiation being allowed to pass through. In the early morning the ionosphere became more transparent, most of the radiation being allowed to pass and at this time the intensity received is greater than that allowed to pass at the time of transit. For this reason it was decided to change the frequency from 18 to 24·9 Mc/s since the ionosphere became increasingly transparent to the higher frequencies, but at the time of writing the paper the modifications in the interferometer were not completed. The original 18 Mc/s array will be retained to give a simultaneous record at a different frequency, and it should be usable in the early morning for some months after completion. Two more rows of dipoles have been added to narrow the reception beam in the N.–S. direction and eliminate some of the station interference which is received at low elevation.

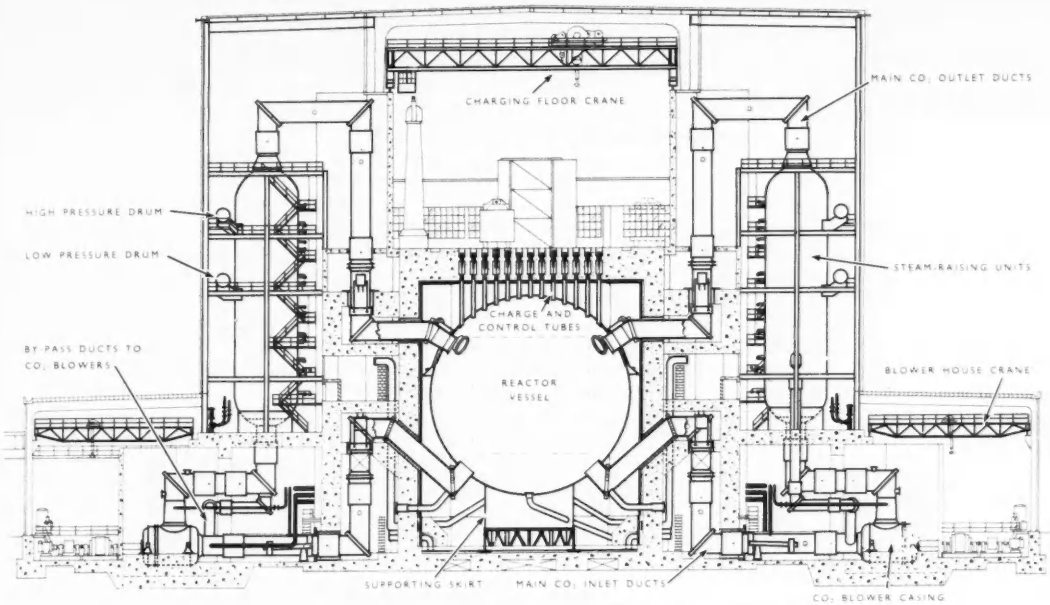
No doubt some very interesting results will be obtained and published soon. Indeed, Jupiter was very favourably placed in the early part of this year, and it is hoped that later investigations will be carried out on polarisation; these could give a clue as to the origin of the emission and could also supply data to the Jupiter Section of The British Astronomical Association. It is intended to search for radio emission from other planets, in spite of the fact that no signals were detected from Mars when it was transiting the meridian in the favourable early-morning period. As Burke and Franklin, at Washington, discovered in April 1955 that Jupiter was emitting radio waves, and in May 1956 Kraus, at Ohio State University, discovered a similar emission from Venus, it is felt that Saturn may be a radio transmitter in view of its atmospheric similarities to Jupiter. Up to the present, however, there is no definite evidence for this.

HINKLEY POINT

The name of Hinkley Point is destined to become as famous as Calder Hall. Designed jointly by English Electric, Babcock and Wilcox, and Taylor Woodrow as the first 500,000 kW atomic power station, it will on completion be the biggest station of its kind in the world. Situated in Somerset, near the Bristol Channel, it is estimated that it can be erected at a cost of only £110 per kW. When operating it should produce electricity at a cost of 0·65 pence per unit, the present average in England.

In construction, it will be similar to Calder Hall, with two reactors, fuelled by natural uranium. Each reactor is graphite-moderated and cooled by carbon dioxide and connected to six axial-flow gas-circulators and six steam-raising units. The lattice of uranium fuel is contained in a spherical pressure vessel, made from three-inch steel and 67 feet in diameter. The uranium rods will be loaded from the top, and this can be done while the reactor is on stream, thus permitting the fuel elements to be moved about to obtain their maximum utilisation. Many detailed improvements on Calder Hall will be incorporated.

The design and erection of this giant atomic power station will demand the best of modern techniques. At Whetstone, near Leicester, where the major design studies are being carried out, a Deuce electronic digital computer, as well as a number of electrical analogue and digital machines are employed to complete the calculations within a reasonable period of time. At the site of erection a huge Goliath crane will be constructed with a lifting capacity of 400 tons; this is the largest of its kind ever projected. The advantage of this enormous crane, about 200 feet high, will be that it is possible to fabricate the shells of the steam-raising units and sections of the reactor pressure vessel on the erecting area and then to transport them to their foundations for positioning. This will greatly speed and facilitate the work on the site. Another interesting point about this crane is the fact that it can be dismantled for transport by road, rail, or sea so that it can be used later for similar jobs elsewhere. Clearly the design companies consider Hinkley Point as the forerunner of similar large-scale atomic power



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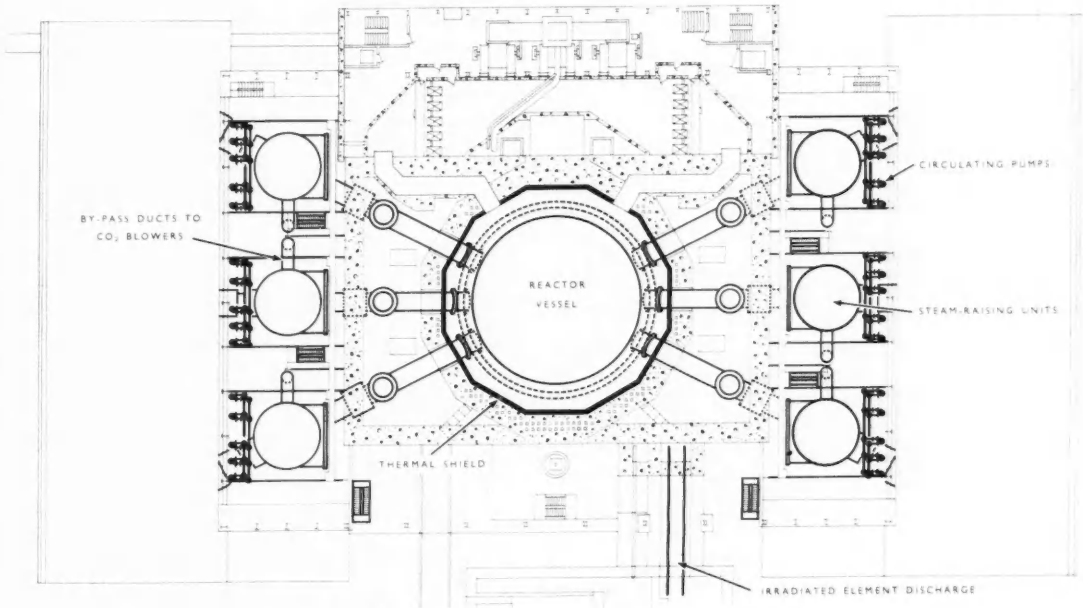


SECTIONAL PLAN THROUGH REACTOR BUILDING

stations, or perhaps even bigger ones. The growth of atomic power has taken such an exponential sweep in the last few years that 1 million-kW stations may soon be the order of the day.

TRANQUILLISING DRUGS

Discussions in the pub have it that, if enough car-loads of tranquillising drugs could be produced, we could empty the mental hospitals and everyone would be happy. Two recent monographs* show how very far this optimism is from being the truth—at least at this time. They are not, however, discouraging of the efforts being made to discover and control the biochemical bases of behaviour. They do indicate clearly how beset such discoveries are with the complications which characterise our present naïveté regarding the multitude of biochemical events that keep us living and behaving as human beings.

Much of the research reported in these monographs, and certainly the current interest in tranquillising drugs, is based upon the assumption that behaviour is significantly influenced by biochemical events in the body. There are many examples of the validity of this assumption. The use of chemical agents to produce sleep, to deaden the perception of pain, to increase endurance and alertness, and to affect behaviour in numerous other ways is centuries old. More recently research has shown that nutritional deficiencies may lead to changes of behaviour and that unusual behaviour patterns may be associated with inherited abnormalities of a biochemical nature. Only a very few of these interactions between biochemical events and behaviour are understood; the two monographs illustrate ways in which scientists from a number of different disciplines are endeavouring to extend our knowledge of these very important relations.

In the monograph he has edited, Dr Himwich calls our attention to the fact that "not infrequently in the history of medicine great advances have been made on an empirical basis". The therapeutic uses of tranquillising drugs represent an advance of this kind. It is also a characteristic of medical science that such discoveries stimulate further research of two general types. One involves extensive clinical examination of the therapy in order to increase confidence in its basic validity and the other, a search for its mode of action.

It is quite fair to ask the question: do the tranquillising drugs represent a major breakthrough in the treatment of mental illness or are they likely to prove as disappointing as a number of other therapeutic methods tried extensively during the past few years? The answer to this question is not a simple one. Reading the monographs cannot help but impress us with the difficulties of clinical research, which frequently allows only such conclusions as: "It appears from the data that the results of the treatment with azacyclonol are variable and depend to a large degree on the individual case." Clinical research is complicated by the large number of variables with which the investigator must concern himself, including individual differences in the behaviour disorders shown by different patients, length of illness, differences in reactions to drug dosages, variability in the duration of effectiveness of treatment, and undesirable side effects. Because of such complications, statements regarding the relative effectiveness of different tranquillising drugs cannot yet be made with the confidence which scientific conclusions generally demand.

The clinical picture which the present writers paint is one of cautious optimism. They report varying percentages of "complete remissions" following treatment with tranquillising drugs; as would be predicted, none of these approaches 100%. There is the suggestion that the drugs serve the useful purpose of making the patient more amenable to psychotherapy and of permitting other, more drastic, somatic methods of treatment to be discontinued. Generally speaking, the drugs appear to abbreviate hospitalisation and to accelerate the process of normal recovery.

In its search for modes of action of the tranquillisers, the monograph edited by Dr Himwich emphasises the view "that the changes of these drugs, wrought on the brain, are the causes of their ameliorative action". Two working hypotheses about the nature of these changes underlie the variety of research results reported. The first, favoured by most investigators, takes the view that the tranquillising drugs affect neural action in specific areas of the brain and that different drugs act primarily on different areas. The second of these general hypotheses is, as its proponents state, "perhaps presumptuous" at the moment and hence appeals to those who believe that science thrives on controversies. It suggests that tranquillising drugs may act upon a diffuse physiological mechanism, rather than numerous specific mechanisms. This mechanism, "diffuse inhibition", exerts a significant influence on behaviour; therefore, any drug which selectively affects the mechanism is reflected in behaviour changes.

Evidence is presented supporting both points of view. Some of this evidence is concerned with changes induced by various drugs at the microscopic junctions between two single nerve cells, other with changes involving the action of a great many cells. Some are expressed in terms of chemical, others in terms of electrical changes. The fact that one of the expert contributors to the monograph feels sufficiently confident to state that "There is definite evidence for the association of a marked chemical change in specific nerve cells with a marked shift in behaviour pattern" indicates how far the search for biochemical correlates of behaviour has progressed. However far this distance is from the final goal, it still is an encouraging approach to the day when our understanding of these correlates will permit the selection of therapies for mental illness on the basis of systematic knowledge rather than merely empirical grounds.

"The more one pries into the bewildering complex of interactions between mind and bodily functions, the less

* Himwich, H. E., "Tranquilizing Drugs", London, Academic Books Ltd, 1957, 197 pp., 35*s*.

Hoagland, H., "Hormones, Brain Function and Behaviour", Washington, D.C., American Association for the Advancement of Science, London, Academic Press, 1957, 257 pp., 56*s*.

one feels able to name precise mechanisms responsible for any one disturbance." This statement, from the monograph edited by Dr Hudson Hoagland, is meant to caution us that there are within the body biochemical events, other than those originating in the central nervous system, which exert important influences on behaviour. Controlling many of these events are secretions of the endocrine glands. The papers in this second monograph are concerned with describing ways in which these secretions, "hormones", act in affecting brain function and behaviour. Hormones "are endogenously produced drugs regulating the internal environment of the cells and modifying many aspects of behaviour". It is known that, in some instances, these hormones exert their influences on behaviour indirectly, by affecting the functioning of the central nervous system. For example, certain hormones from the adrenal gland have a regulatory influence on the excitability of the brain, which in turn affects behavioural processes of perception and response. In other instances, such as sex behaviour, it is apparent that certain hormones are essential to the initiation and maintenance of behaviour patterns, although little is yet known of the relations between the hormone action and neural functioning.

To review these monographs in such general terms is to do them a grave injustice for their value arises to a great extent from the detailed information and ideas they record. Many of these ideas will be altered in the light of future research, but they are all part of a scientific attack on the great complexity of biochemical events underlying behaviour. To understand the details clearly requires a background of knowledge which is not available to readers generally. This means that the monographs will not find places on the current book-shelves of many readers. They will, however, be "required reading" for all who wish to keep up to date in their understanding of the biochemistry of behaviour and its practical applications to the problems of mental illness. It is always exciting to become acquainted with a frontier of science and this is the feeling one has in reading these monographs.

THORIUM SHOWS GOOD BREEDING

With the report from Harwell that the new reactor at Winfrith Heath, Dorset, is to use thorium in place of uranium as fuel, a new chapter will be added to the remarkable history of an element discovered by Berzelius more than a century ago. By using thorium the initial cost will be lower and the efficiency raised. In a "breeding" reactor, Uranium$_{233}$—to which Thorium$_{232}$ as sole natural isotope is converted just as plutonium is derived from U_{238}—is more easily separated from the original thorium than is plutonium from uranium. There are less health hazards, it is claimed. Estimates of reserves give thorium as constituting 0·0012% of the Earth's crust, compared with uranium forming 0·0004%. Thorium is thus as common as lead.

Before Madame Curie, in Paris, and Schmidt independently at Münster, noted that thorium, like uranium, is radioactive, the rare element had assumed considerable importance as thoria in the gas-mantle industry. Baron von Welsbach, a one-time student under Bunsen at Heidelberg, had taken to the study of rare earths from the purely scientific point of view. He had separated praseodymia and neodymia, for example, and had thus explained the two groups of absorption bands in the didymia spectrum as noted by Brauner of Prague. But Welsbach's most striking achievement came when he soaked cotton threads in rare earth salts, noted the brilliant glow when these were placed in the Bunsen flame, and went on to invent and patent the gas-mantle in September 1885. Welsbach, incidentally, added a second discovery linked with his first. He was irritated because dumps of cerium residue were left near factories, and because manufacturers gave away one pound of cerium salts with every hundred pounds of thorium salt purchased. Welsbach made an iron-cerium alloy yielding bright sparks when scratched, an alloy which, as so-called "flints", was used in the automatic gas-lighter and the modern petrol lighter.

From 1886 until the gas-mantle went out of general use, thorium was important enough for Germany to acquire a monopoly in thorium minerals before the First World War banished this monopoly. From the economic point of view only monazite sand, in which weathering has concentrated the honey-yellow grains of rare earths, proved workable. The sand included up to 18% thoria as maximum, together with cerium phosphate and other earths. It came first from Brazil, whence it was smuggled as ship's ballast. A total of 75,000 tons were exported before 1947, when the Brazilian National Congress suspended exports of what is now a strategic material, "a prescribed substance" not to be mined or marketed without a licence. Yet Brazilian beach sands proved inferior to the well-known Travancore monazite sands. By 1938 it was claimed that 88% of the world's monazite came from India. Here again, exports became suspended in 1948 with the Indian Atomic Energy Act. Thorium supplies from Idaho, South Africa, and as by-product from Nigerian and Malayan tin-mining, represent alternative sources today.

Thorium metal, first prepared by reduction with potassium of the fluoride, then by sodium reduction of the chloride, is now produced by calcium reduction of the oxide or by electrolysis of a molten bath of double fluoride with potassium. In atomic physics thorium has become a "hush-hush" element, only "non-energy" production details being published. Thorium staged a come-back after its decline when electric lighting limited the Welsbach gas-mantle to rural areas or where the pressurised paraffin lamp is still used for illumination. It is now used in thoriated tungsten filaments of better stability than those solely of tungsten, in gaseous-discharge lamps, in thoriated welding electrodes, in x-ray targets for giving a strong source of monochromatic, and in photo-electric tubes for measuring a wide band of ultra-violet.

Thorium, named after Thor, god of war, will prove, it is hoped, a greater boon in peace-time applications of atomic energy where, as it is laconically said, it shows "good breeding".

SCIENCE AND CIVILISATION IN CHINA

Dr Joseph Needham's insatiable thirst for knowledge and unremitting drive are known to nearly every scientist in China, and his respect and affection for China reciprocated. During the hard and bitter years of struggle against Japanese invasion, when Chinese scholars felt hopeless and isolated, he was appointed as Scientific Liaison Officer to the British Embassy in Chungking. From 1942 to 1946 he travelled the length and breadth of China, visiting every scientific institution, bringing apparatus, chemicals, books, microfilm, journals, information, and ideas, and sending outwards for Chinese scientists a stream of learned papers recording work accomplished amid mountainous difficulties. During this period Dr Needham made friendships with Chinese scholars who have helped him to an acquaintance with Chinese literature unrivalled in the West. His "Science and Civilisation in China"* is the result. Building on a solid foundation of knowledge of both modern and ancient written Chinese, he has been able to discuss with Chinese experts problems of source material, interpretation, dating, and authenticity, and finally to write with authority a work which presents with convincing enthusiasm a picture of early science previously almost entirely unknown outside China.

These volumes are the first two of seven which will form a detailed record of Dr Needham's remarkable discoveries in the history of Chinese science. The first volume sets out the information which he regards as necessary background—highly compressed but very readable accounts of Chinese geography, history, language, and scientific literature. Nearly half the book is concerned with the travel of goods and ideas between China and Europe, with fascinating glimpses of the treasures to be fully revealed in succeeding volumes. We read, for instance, of the old silk road across Asia, of sea-going junks that traded on the east coast of Africa, of the monk Fa-Hsien who travelled overland from China to India and back in the early 5th century, of the 2nd-century astronomical telescope with automatic clock-drive, of Nestorian Christians in 8th-century China, of ancient discoveries of a lunar cycle of the sea-urchin, and of Friar Odoric watching in Hangchow the feeding of three thousand apes which, he was told, were "nought else but the souls of gentlemen".

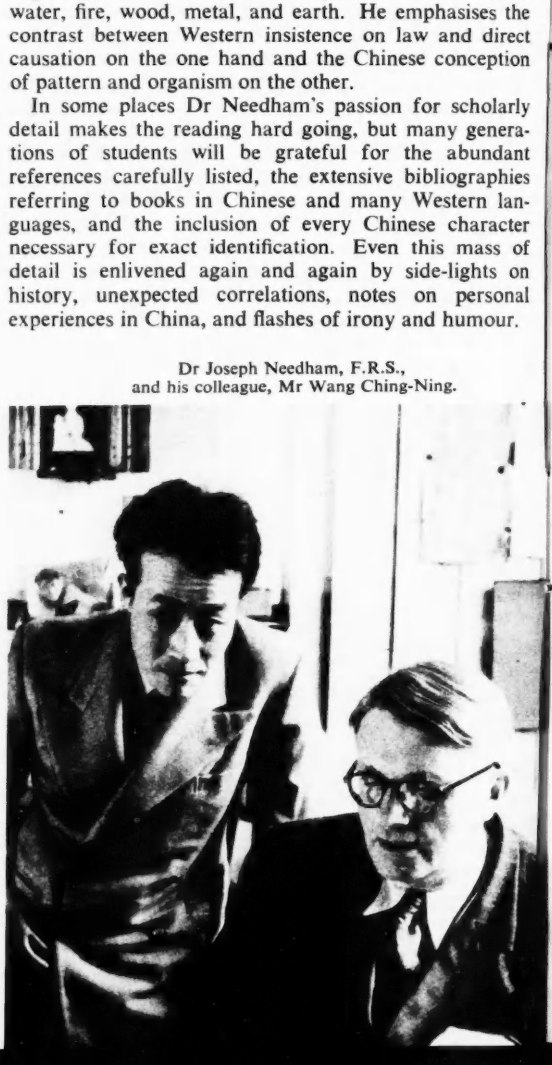
The main thesis stated in the first volume is that up to the 17th century the West gained far more than did China from the slow exchange of inventions and techniques. Dr Needham lists four inventions transmitted from Europe to China (screw, double force-pump, crank-shaft, and clockwork), whereas he lists about thirty mechanical or chemical inventions or techniques which travelled from East to West. His evidence will follow in later volumes, where he intends to show priority of China (by approximately the number of centuries indicated within the brackets in each case) in the use of piston-bellows (14), drawloom (4), wheelbarrow (9), cast iron (10), gunpowder (5), lock-gates (7), paper (10), deep drilling (11), cross-bow (13), kite (12), iron-chain suspension bridge (10), magnetic compass for navigation (2). This is only part of Needham's list.

Assuming that Dr Needham will be able to substantiate these claims—and the quality of the research which he here describes leaves little doubt that he will—we are forced to realise that the old question as to why science failed to develop in China must be replaced by the much more cautious one: "Since the Chinese people have shown ability to observe and invent surpassing that of the West until comparatively recent times, what factors in environment and thought carried them so far and yet prevented the development of the full scientific method?"

In his second voulme, Dr Needham surveys Chinese philosophies in a sustained attempt to discover the reasons for Chinese success and failure in science. He is able to illuminate much in Chinese culture that has usually been dismissed as quaint superstition—for example, the ideas behind *yin* and *yang* and the eight trigrams, and the elaborate theory of the five elements: water, fire, wood, metal, and earth. He emphasises the contrast between Western insistence on law and direct causation on the one hand and the Chinese conception of pattern and organism on the other.

In some places Dr Needham's passion for scholarly detail makes the reading hard going, but many generations of students will be grateful for the abundant references carefully listed, the extensive bibliographies referring to books in Chinese and many Western languages, and the inclusion of every Chinese character necessary for exact identification. Even this mass of detail is enlivened again and again by side-lights on history, unexpected correlations, notes on personal experiences in China, and flashes of irony and humour.

Dr Joseph Needham, F.R.S., and his colleague, Mr Wang Ching-Ning.



*Vol. I. Introductory Orientations; vol. II. History of Scientific Thought. (Cambridge University Press, vol. I, 1954, 318 pp., 52*s.* 6*d.*; vol. II, 1956, 696 pp., 80*s.*)

Later volumes will contain detailed accounts of ancient Chinese mathematics and astronomy, physics and engineering, chemistry, and biology and medicine. Dr Needham has already described such rich results from his explorations into the East and the past that the full display of his discoveries will be awaited impatiently by specialists in every branch of science. This book will become a work of reference of permanent value wherever the history and social environment of scientific discovery is a matter of interest and concern.

IS THE "RIVAL WORLD" A RIVAL?

Attention has recently been focused upon the "Rival World"* by a film of that name. The importance of insects in the transmission of disease in man and domestic animals and even more in the destruction of crops, timber, and stored produce should not be underrated. Nevertheless, it may be worth pausing to consider whether their new title may not reflect a popular misconception.

Do insects, in fact, present any serious challenge to human supremacy in the world? When the question is framed so bluntly, few scientists will be likely to answer in the affirmative unless they have recent experience of a locust plague (or some equally dramatic and forcible exhibition of insects in the mass). The misconception lies in the nature or absence of any qualifying clauses. As every ecologist knows, extravagant claims are frequently made about animals which, on inspection, turn out to be meaningless.

An example is afforded by the oft-repeated statement that, if all were to survive, the progeny of a single pair of aphids would, within a season, produce a heap of insects as high as Mount Everest. From an ecological point of view, the animal does not exist independently of its environment. Not only do innumerable aphids fall victim to various predators and parasites, but even if this were not so, food shortage would impose a check to further increase in numbers long before there were enough to build even a small molehill!

The factors of the environment that regulate the sizes of animal populations are both biological, including other animals and plants, and climatic. At the present time there is considerable disagreement among zoologists as to the relative importance of these factors. One school of thought, headed by Dr A. J. Nicholson, takes the view that the agents which determine population densities in nature can be divided into two groups: density-dependent and density-independent. Density-independent factors are defined as those which bear equally heavily upon a population, whether its density be great or small; undoubtedly the most drastic are physical or climatic. But, it is argued, if a particular factor of the environment is to *regulate* the population density of a species by holding it within definite limits, it must be able to destroy a greater fraction of the population of that species when its density is high than when it is low. If destruction were merely proportional to population density, the factor causing it could not be regulatory. Thus climate alone cannot control or regulate animal numbers.

Of the density-dependent mortality factors which play most heavily upon a population when it has reached a maximum density, competition between individuals for shelter and food, predators, disease, and the affects of migration are probably the most important.

The second faction, of which Drs H. G. Andrewartha, L. C. Birth, and W. R. Thompson are the chief exponents, thinks that natural control is achieved chiefly by climate and that it is unnecessary to invoke density-dependent factors to explain either the maximum or the minimum numbers occurring in a natural population. Admittedly many insect species do seem to spend most of the time recovering by annual increases from occasional climatic setbacks.

No doubt the truth lies somewhere between these two extremes. Possibly climate may control the more normal fluctuations in the numbers of a species while density-dependent factors are significantly invoked only when maximum or minimum densities are reached. In any case, no one will disagree with the statement that population sizes are directly controlled by environmental influences of one sort or another. If these are sufficiently complex, no one species can become too numerous: but where they are simpler, it is easier for plague proportions to be reached.

For instance, Arctic animals such as snowshoe rabbits and lemmings show marked cycles in numbers, at the upper limits of which mass emigrations occur. The regularity of the cycles may well be because the basic predator-prey oscillation is little disturbed by other factors. In contrast, as Dr J. R. Audy has emphasised, the equatorial rain-forest, because of its extreme complexity, has the greatest inherent stability of any biogeographical region. A tremendous richness of species tends to give a buffering effect to any unusual population change.

Now man's activities tend, on the whole, to create simpler conditions than would normally occur on nature. The growing of crops, the herding of animals, bulk storage, urbanisation—all these result in a relative lack of natural checks to sudden population increases. For economic reasons man destroys complexity and replaces it by large tracts of uniformity. Consequently conditions conducive to plagues of one form or another are inevitably created by the activities of human beings and any "rival world" is of our own creation. The challenge to mankind arises from the fact that technological advances have outstripped fundamental biological knowledge in this respect. Of greater interest really is the question whether, in view of this, the "economic reasons" for uniformity are fully justified.

* The "Rival World", a film made by Shell about insects and their challenge to mankind.

BIBLIOGRAPHY

Andrewartha, H. G., and Birch, L. C., *The Distribution and Abundance of Animals*, Chicago, 1954.

Audy, J. R., in *The Numbers of Man and Animals*, London, 1955, pp. 145–6.

Cloudsley-Thompson, J. L., *Entomologist*, 1957, vol. 90, pp. 195–203.

Nicholson, A. J., *Austr. J. Zool.*, 1933, vol. 2, pp. 9–65.

Thompson, W. R., *Ann. Rev. Ent.*, 1956, vol. 1, pp. 379–402.

FIG. 1. Aerial view of CERN site at Meyrin (June 1957). Proton Synchrotron (*top right*); Synchro-cyclotron (*middle front*).
(*All photographs reproduced by the kind permission of CERN.*)

CERN: EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH

C. J. BAKKER
Director-General, CERN, Geneva

The European Organisation for Nuclear Research was formed three years ago by twelve European nations to undertake co-operative basic research in high-energy nuclear physics. Near the little Swiss village of Meyrin, near Geneva, the Organisation has been busy these last three years putting up a vast physical laboratory for the future use of European nuclear physicists. On what used to be rolling farmland, modernistic laboratory buildings rise against the backdrop of the Jura mountains. Here more than 500 scientists and technicians are already hard at work shaping the home of the world's first truly international research centre.

The centre, which is commonly known as CERN from the initials of the original French name for the Organisation, is being built around two big particle accelerators, of which one—the 600-million electron-volt (600 MeV) Synchro-cyclotron—is now ready for operation.

Another, and far more powerful machine is also being constructed. This is the 25,000-million electron-volt (25 GeV) Proton Synchrotron, a gigantic instrument of revolutionary design, which will give the scientists of Europe a unique tool for extending the knowledge of the vast field of high-energy nuclear physics. When the Synchrotron is finished in 1960, Europe will be well equipped for the fundamental research in this highly important field of physics, and its facilities will be among the best of the world.

The idea of a central European physical laboratory was first vaguely discussed in scientific circles during the first post-war years. The basis for these private talks was the clear realisation that no single European country

could afford the enormous expenses involved in building the high-energy accelerators required in modern nuclear research. It would also be difficult for a single country to find the experts, first to build, and later to run these huge machines, and carry out experimental work with them.

The subject had its first public airing in December 1949, when an important message of Louis de Broglie was read at the European Cultural Conference at Lausanne. Prof. I. I. Rabi, of the United States, pursued the problem at the General Assembly of UNESCO at Florence in 1950 by tabling a resolution which encouraged the formation of regional research centres and laboratories. Prof. Rabi did not mention any specific field of research or suggest any particular region, but nuclear physicists in Europe immediately saw the chance for their dream to be realised.

THE REAL HISTORY OF CERN

One may say that the real history of CERN began in May 1951, when the Director of the Natural Science Department of UNESCO, Prof. P. Auger, invited a group of European experts to investigate the possibilities for a European nuclear research laboratory. This resulted in a project of a European research laboratory taking shape, and on February 15, 1952, ten of the European member nations of UNESCO signed an agreement in Geneva for the establishment of a "Council of Representatives of European States for planning an International Laboratory". The provisional Council, which was called CERN (Conseil Européen pour la Recherche Nucléaire) had as its primary aim to prepare plans for particle accelerators for future research, as well as the contents of a Convention for a permanent organisation. The planners went to work with great enthusiasm, an enthusiasm which has been a characteristic of CERN ever since.

Britain was not a member of the provisional Council, but throughout the preparatory period British scientists and administrative experts played an informal but active part in drawing up the blue-print for the permanent set-up.

Finally, on July 1, 1953, twelve States signed the Convention for the permanent organisation at the Quai d'Orsay in Paris. The founding members were Belgium, Denmark, France, the German Federal Republic, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom, and Yugoslavia.

By September 29, 1954, the Convention was ratified by a sufficient number of States, and entered into force. A few months later all participating nations had ratified the agreement, and work was proceeding at a feverish rate on the 48 hectares building site at Meyrin.

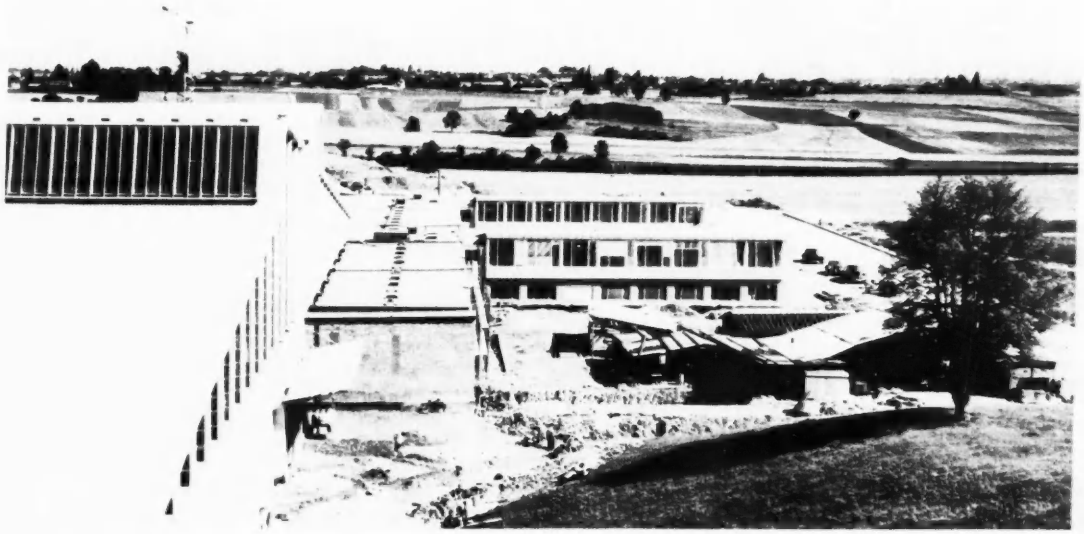
THE PURPOSE OF CERN

The purpose of CERN is laid down in Article II of the Convention, which says:

"The Organisation shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character and in research essentially related thereto. The Organisation shall have no concern with work of military requirements and the results of its experimental and theoretical work shall be published and otherwise made generally available."

This article immediately set CERN apart from all other existing international organisations and nuclear research establishments. Firstly, CERN is a co-operative working organisation, and not just a co-ordinating

FIG. 2. Proton Synchrotron. The main experimental hall.



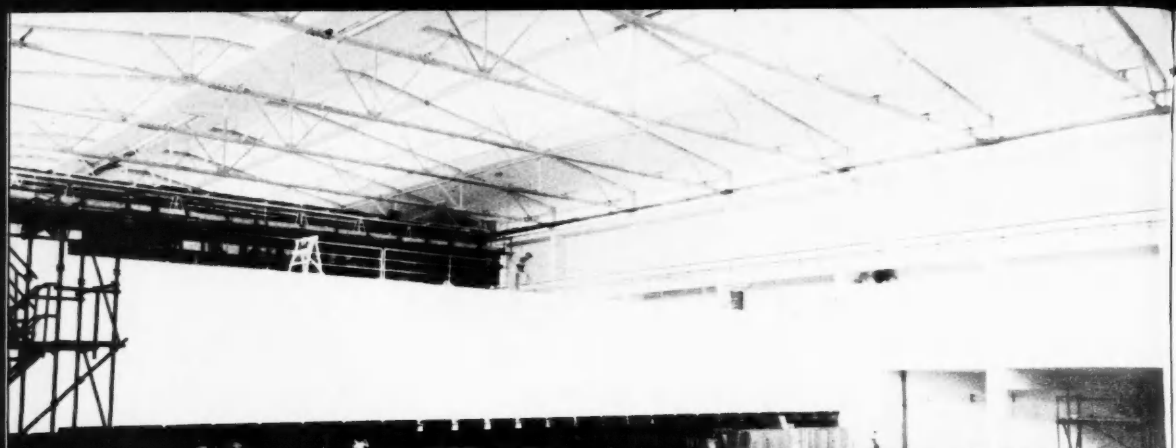


FIG. 3. Proton Synchrotron. Part of the main experimental hall with shielding for beam exit.

liaison organisation like many other international bodies. Secondly, CERN is deliberately keeping clear of the field of nuclear energy, thereby avoiding being involved in the military or commercial aspects of nuclear science. Thirdly, CERN is a completely open Organisation. No security clearances are necessary to visit the laboratories. All results of scientific or technical research are being published rapidly and fully. The Organisation does not even apply for patent rights for inventions made during the development of the research centre.

BASIC WORKING PROGRAMME

The Convention proceeds to lay down a basic working programme in three points: (*a*) "the construction of an International Laboratory for research on high-energy particles, including work in the field of cosmic rays"; (*b*) "the operation of the Laboratory . . . "; (*c*) "the organisation and sponsoring of international co-operation in nuclear research, including co-operation outside the Laboratory".

Under point (*a*) CERN is constructing two large particle accelerators. The most important of these two machines is the Proton Synchrotron* which will ultimately deliver fast protons with an energy of 25 GeV. This machine, which at least for some time will be the biggest accelerating machine in the world, uses the alternating gradient focusing principle in guiding the particles in their path. This system has its decided advantages from the point of view of cost, but the incredible accuracy involved in building the instrument has put the designers and engineers on an almost superhuman test.

Great care must be taken in building the 200-metre diameter annular housing for the 3500-ton guiding magnet. The magnet, which will be made up of 100 magnet units, will rest on a bridge-like beam of almost scientifically mixed special concrete. To avoid adverse effects from the instability of the ground, the beam is being supported by eighty huge concrete pillars which stand safely embedded in the underlying rock. Each of the 100 magnet units will have to be put in place with an accuracy of one part in one million. The 630-metre-long tunnel, which could easily pass for an underground train tunnel in London, will be kept at a constant temperature by air conditioning.

To give an idea of the enormity of the structure, I can mention that the main experimental hall adjoining the magnet tunnel is 100 metres long. Further, to protect the personnel in the experimental halls from dangerous radiation, and to avoid background radiation during the experiments, it was necessary to construct an elaborate shielding system. The huge shielding bridge with a free span of 50 metres, contains 17,000 tons of heavy prestressed concrete and baryte concrete shielding blocks.

To move the experimental equipment around in the halls, one big 30-ton overhead crane and two 20-ton cranes have been installed in the experimental halls.

The tunnel and the adjoining buildings have now been almost completed. For the next three years the large instrument itself will be assembled. Installation has already started at the injection end, where a Cockcroft-Walton generator and an Alvarez-type linear accelerator will give the packets of protons a flying start so that they have an energy of 50 MeV when they enter the vacuum chamber of the accelerating ring.

In order to be able to start research before the "big" machine will be available in 1960, it was decided to go

* Adams, J. B., "Some Engineering Problems of the CERN Proton Synchrotron", DISCOVERY, vol. 18, No. 7, July 1957.

ahead with the construction of a "small" machine—the 600 MeV Synchro-cyclotron.

This machine, though it does incorporate novelties in the design, is of a conventional cyclotron pattern, and could be built rapidly. It was built so rapidly in fact, that today, little more than two years after construction of the machine started in earnest, the Synchro-cyclotron is practically ready for use, its 2000-ton magnet with almost flawless field characteristics. The machine has already been run to its full power. It only remains to add the outlets for the particle beams to bring them into the experimental halls.

The CERN Synchro-cyclotron is the third biggest in the world, slightly bigger machines being in operation at the Radiation Laboratories at Berkeley, California, and at the Joint Institute for Nuclear Research at Dubno, near Moscow.

During the construction period CERN has already undertaken a sizeable amount of high-energy studies at the cosmic-ray station at Jungfraujoch, a 4000-metre mountain peak in central Switzerland. Also, a large double Wilson cloud chamber is in operation in Geneva, and it is planned to continue this branch of CERN activities as long as valuable experimental results can be expected.

A theoretical group works in close collaboration with the experimentalists on the planning of future experiments to be carried out with the accelerators. Later the theoreticians will of course also be engaged in interpreting the experimental results.

PERSONNEL

Who, then, will do the scientific work with the machines and the mass of equipment which is now being assembled at Meyrin?

Here it is necessary to touch once again on the basic idea behind CERN—to give European scientists experience and training, and the opportunity to work with equipment which they would otherwise have to look for on other continents. A plan has been drawn up so that the maximum number of scientists from Member States may profit from the costly installations.

For this reason a fellowship scheme has been worked out, giving young post-graduate scientists the opportunity to come to CERN for a period of one year or longer. Already about thirty fellows are working at CERN in close collaboration with the hard-core CERN staff.

In addition, a grant generously made by the Ford Foundation has made it possible for scientists from non-member countries to come to Geneva. Among non-Europeans now working at CERN are scientists from the United States, Japan, India, and China. The Ford grant also makes it possible for CERN to maintain fruitful contacts with non-member countries by inviting well qualified scientists for briefer stays with the Organisation.

Apart from the individuals drawn into the work of the Organisation, CERN will also be prepared to receive teams of scientists from the Member Countries for work with the machines. The teams would bring specific problems to solve, and would to a great extent work with their own auxiliary equipment, brought from their home bases.

It is obvious that with four categories of people wanting to use the machines—fellows, visiting scientists, visiting national teams, and CERN staff scientists—a "rationing" system will have to be worked out to avoid conflict of interest and to ensure the most efficient use of the equipment.

PROMOTING INTERNATIONAL CO-OPERATION

CERN is not only concerned with scientific research at the Meyrin centre. The Convention specifies that CERN shall try to promote international co-operation even outside the Laboratory.

CERN sponsored a symposium on high-energy accelerators at Geneva in 1956, with participation from many nations, including fifty participants from both the United States and Soviet Russia. The symposium was the first effort to bring nations together for a free exchange of experiences and ideas in the field of nuclear science. The conference was a success beyond the wildest expectations of the organisers. It yielded extremely valuable information, and gave the opportunity for close personal contacts.

The two-volume proceedings of the symposium is now becoming a standard work of reference in libraries of nuclear institutes all over the world.

The CERN symposium will probably become a fixture on the world's calendar of conferences, alternating with the famous conference on high-energy nuclear physics being held at Rochester, New York, and, as it is hoped, with conferences in Moscow.

CERN is also spearheading a drive for much-needed standardisation of nucleonic equipment with an advisory conference in Geneva this year. Instrumentation experts from all Member Countries are expected, and it is hoped to attain recommendations for a standard set of specifications for this type of instrumentation.

POLICY AND ORGANISATION

Who sets the policies for CERN and keeps the Organisation running? One would think that such a complex Organisation with possible conflict of interest between politics and science would be very difficult to run. That is not so. Both the external and internal forms of organisation are very simple and function smoothly.

The supreme body of CERN is the Council with twenty-four members, two from each Member State. One member is usually a distinguished scientist, and the other is a top administrator. The Council, the President of which is now Sir Ben Lockspeiser of Britain, discusses and takes all major decisions on CERN policy at two annual meetings. A smaller body, the Committee of the Council, meets more often and takes care of current affairs.

Advising the Council on questions of research plans is a unique body, the Scientific Policy Committee, which works under the chairmanship of Prof. W. Heisenberg of Germany. The members of this important committee

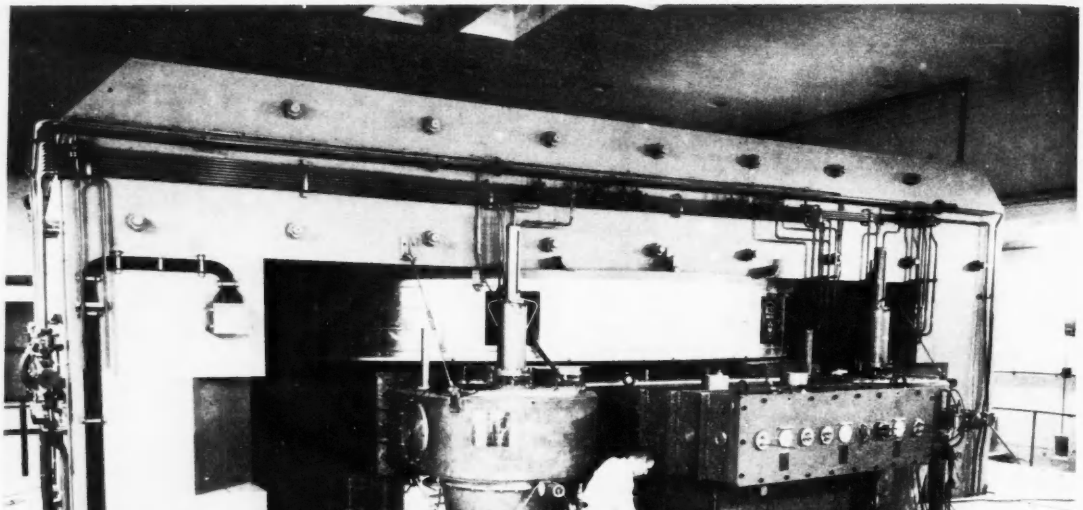


FIG. 4. The Synchrotron-cyclotron with part of vacuum pumps showing (June 1957).

are selected according to their standing as scientists, and not according to nationality. Thus the membership includes Prof. L. Leprince-Ringuet of France; Prof. N. Bohr, Denmark; Prof. H. Alfvén, Sweden; Prof. G. Bernardini, Italy; Prof. P. M. S. Blackett and Sir John Cockcroft, Britain; and Prof. P. Scherrer, Switzerland.

A Finance Committee advises the Council on budgetary questions.

Internally, CERN is organised in six divisions under the Director-General. There is a division for each major field of activity: one for each of the accelerating machines, one for theoretical physics, one for scientific and technical services, one for the site and buildings, and one for administration.

The Scientific and Technical Services Division concerns itself with instrumentation in conjunction with the accelerators, runs a small plant for making liquid hydrogen, operates the computor services and the library services, runs a technical information service, and carries out the necessary photographic work.

The Site and Buildings Division oversees the construction work now in progress, and runs the common services necessary at a laboratory of this size.

Currently 580 scientists, engineers, technicians, and administrative personnel are employed with the Organisation. The personnel comes from all twelve Member Countries, but not necessarily in proportion to the size and population of each country. The guiding principle in appointing personnel is: "The best man or woman available for the job at hand."

FINANCE

What does all this cost, and how is the construction and operation of CERN financed?

The cost is of course heavy, but not quite as high as one might be tempted to think. Over the seven-year construction period ending in 1960, CERN might well spend close to 250 million Swiss francs. Capital investment is calculated to be two-thirds, while research and operating costs will draw approximately one-third of the total. The Budget for 1957 comes to about 60 million Swiss francs.

The main factors in keeping the cost down are careful planning, and the fact that CERN, by virtue of its European character, may "play" the European market for goods and services. For every major delivery, tenders are invited from firms all over the Continent and Britain; and the CERN purchasing office, in consultation with the scientific experts, are able to pick the best and most reasonable offer. In practice it works out that almost every member nation has contributed some piece of equipment or some kind of service to CERN.

CERN is a very young Organisation, but it has come far in its first years of existence. Already the Organisation begins to pay dividends, not only in the form of hard scientific results and facts, but also in the form of better contacts and understanding among European scientists, and between European scientists and their colleagues in the rest of the world. If we succeed in continuing and in improving, the intensive efforts and high costs will have been well worth it.

FITNESS FOR PARASITIC LIFE

GEOFFREY LAPAGE, M.D., M.A., M.Sc.

Much has been written about the remarkable ways in which animals of all kinds have become adapted to their various ways of life. Familiar to most readers will be the special adaptations of such animals as birds, whales and seals. Not so well known, perhaps, are the no less remarkable and beautiful ways in which animals that are parasitic are adapted to their parasitic lives. These animals are, whatever we may think of their way of life, doing what all other animals, including man, are also doing—they are getting their food, reproducing their kind and fighting the continual battle that all living things have to fight, the battle with the risks of life, on which the survival of the species depends.

The distinctive thing about the parasitic animal is the way in which it gets its food. It must get this from the body of another living organism called its host. But the parasite always does its host some kind of harm, and this fact, the harm done by the parasite, is also distinctive of parasitism. It does not mean that the host is always killed by the parasite, nor that the harm done to the host always amounts to a disease. Very often, in fact, the health of the host is not very much upset, or it is not upset at all. But the harm done by the parasite is always there and it is the mark of parasitism. If we add to this the facts that the parasite is usually smaller than its host and is therefore usually one of the invertebrates and that, in order to get its food, the parasite must live inside, or on the surface of, the body of its host and must establish a physiological relationship with the host, we have defined parasitism pretty well as clearly as we can.

It is often said, and to some extent it is true, that parasitic life causes simplification of the structure of the animals that adopt this way of life. The tapeworm, for instance, which lives in the food inside its host's food canal, has lost its own food canal and feeds by absorbing, through its skin, the food amid which it lives. The fleas, and lice, which live amid the hairs and feathers on the surfaces of the bodies of their hosts, have lost their wings, which would be a hindrance to life in this situation; and a long list could be given of other simplifications of structure that have resulted from parasitic life.

Apart from these simplifications of structure, the *shape* of the body of a parasitic animal may be altered to suit the environment in which it lives. Thus the tapeworms and roundworms which live in the food canals of their hosts have elongated bodies. The mites that live inside the quills of the feathers of the fowl and other birds have elongated bodies suited to life inside these cylinders; and the mite, *Demodex*, which lives inside the narrow tubes (or hair follicles) out of which the hairs of its hosts grow, shows a similar departure from the more globular shape of the bodies of its relatives.

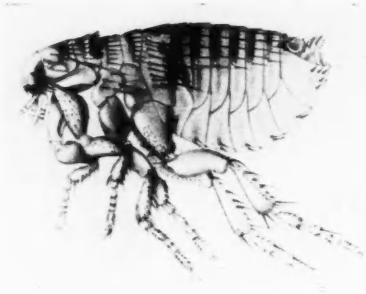
Another example of modification of the general body-shape to suit special habits of life is the lateral flattening of the smooth and shiny body of the flea, which helps it to move freely among the hairs and feathers of its hosts and to evade capture there. The lice, on the other hand, which live in the same situation, have bodies flattened from above downwards. The feet of both these kinds of parasites bear hooks which enable them to maintain a hold on the hairs and feathers.

The alterations of individual organs that help the parasite in other ways are very numerous. Many of them are associated with the parasite's need to hold on to the host and to get food from it. Thus many parasites develop various kinds of hooks and suckers; some of these are solely organs of adhesion for the job of holding on, while others, developed around the mouth, also help in the business of getting food.

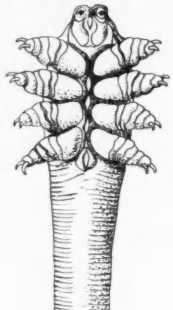
ADAPTATIONS FOR OBTAINING FOOD

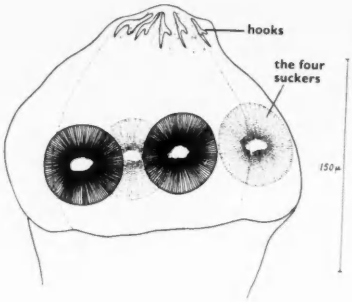
Special adaptations for obtaining food are numerous. When the parasite does not feed on blood, it feeds on the solid tissues of its host and the mouth is then equipped with special tools with which it can nibble bits off the host's body. Thus the mouthparts of the lice that do not suck blood are adapted for chewing scales and epithelial debris present on the skins of their hosts; some of these parasites can even bite off bits of hairs or feathers and chew them. Some worms that live in the food canals of their hosts have powerful, bell-shaped mouths, behind which there is a sucking apparatus which enables the worm to suck in a plug of the lining of the host's food canal. Teeth inside the bell-shaped mouth then rasp pieces off this plug of tissue. Some of these worms (e.g. the hookworms and the redworms of horses) combine this method of feeding with blood-sucking and, when these worms are numerous, they may suck out so much blood that the host is bound to suffer from anaemia. It has been calculated, for instance that fifty dog hookworms can remove nearly two tablespoonfuls of blood every day. The loss of blood by the host is all the greater because these worms, like other blood-sucking parasites, make and inject into the host substances called anti-coagulins which prevent the clotting of the blood.

Among the insects, too, there are many species that feed on the blood of their hosts and these develop very efficient blood-getting tools. The mouthparts of mosquitoes, for instance, are elongated to form a very efficient proboscis with which the mosquito pierces the host's skin and sucks blood. The elongated upper lip forms the roof, and the elongated tongue (hypopharynx) below it forms the floor, of a slender tube up which the blood is sucked. The mandibles and first maxillae are slender stylets, the latter being toothed to enable them better to pierce the host's skin. The lower lip forms a kind of gutter in which the other mouthparts lie when they are not in use. On the free end of it there are two small lobes called labella. When the mosquito feeds, it first feels with its maxillary palps for a suitable place on

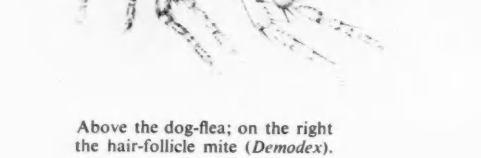


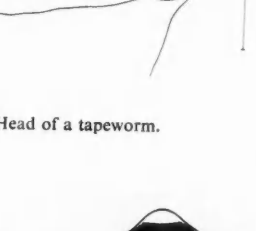
Above the dog-flea; on the right the hair-follicle mite (*Demodex*).



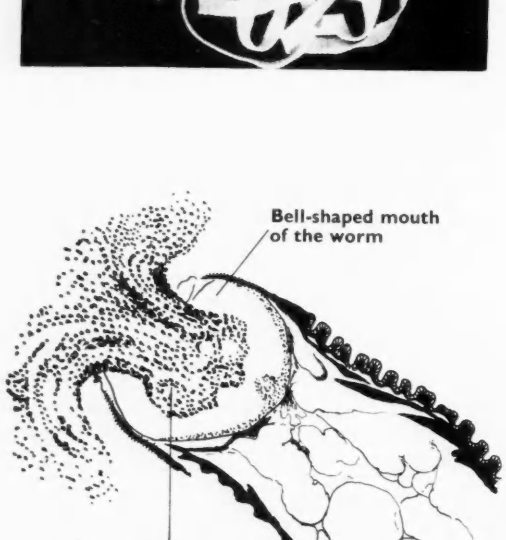


Head of a tapeworm.

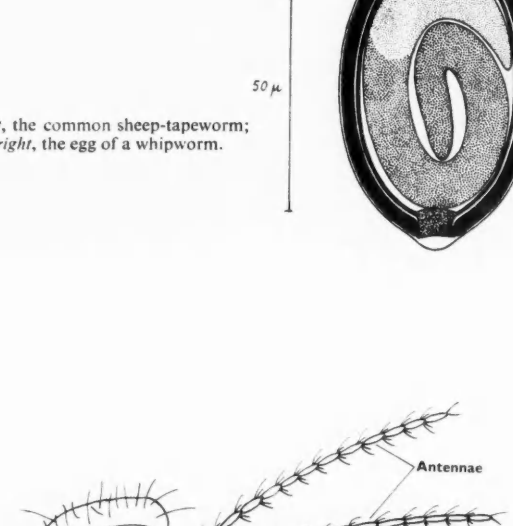




Left, the common sheep-tapeworm; *right*, the egg of a whipworm.



Head-end of a horse redworm attached to the lining of a horse's large intestine.



The mouthparts of a female mosquito.

the skin of the host. Then, having found this, it thrusts the upper lip, mandibles and maxillae through the skin, using the two lobes on the end of the lower lip (labella) to guide them, much as a billiards player uses his fingers to guide his cue. As the slender stylets enter the skin and the head of the mosquito comes nearer to it, the lower lip, which does not enter the wound, is bent downwards in the form of a loop.

The mouthparts of the blood-sucking horseflies or clegs are made up of the same parts, but they are shorter and coarser and for this reason they inflict more painful and more irritating bites. These swiftly flying flies breed, as the mosquitoes also do, in water and damp places and for this reason people on the banks of streams and rivers are often bitten by them. The mouthparts of the tsetse flies, which suck the blood of man and wild and domesticated mammals in Africa only, are different from those of the mosquitoes and horseflies. They consist only of the upper lip and tongue, which together form the tube up which the blood is sucked, and the powerful, club-shaped lower lip, which is deeply grooved to contain the other mouthparts and is held pointing forward like a bayonet underneath the head. The bites inflicted by this formidable apparatus can be painful and very annoying. The mouthparts of the stable flies, which look very like houseflies and are often mistaken for houseflies until they inflict a painful bite, are similar to those of the tsetse flies.

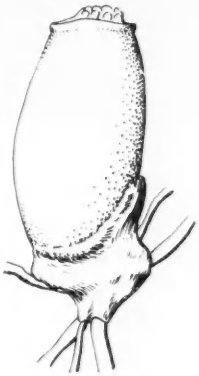
FOOD

The food of parasitic animals, whether it consists of solid portions of the host's body or the liquid blood or any other tissue juices of the host, can be obtained only from the host and only from the right kind of host. Any animal will not do. Thus the human malarial parasite cannot live in any animal but man; most of the worms that live in the intestines of horses and sheep and cattle cannot live in a human being; the small parasites that cause coccidiosis of chickens cannot live in ducks and geese. The parasitic animal is therefore up against the problem of finding the right kind of host. Having found this host, it must enter its body and overcome the host's resistance to it. When this has been accomplished, the parasitic animal is all right. It can live in the midst of an abundance of food and there grow up and reproduce its kind. Its offspring must, in their turn, enter the bodies of the right kinds of hosts and succeed in living inside these hosts or on the surfaces of their bodies. How do they accomplish this?

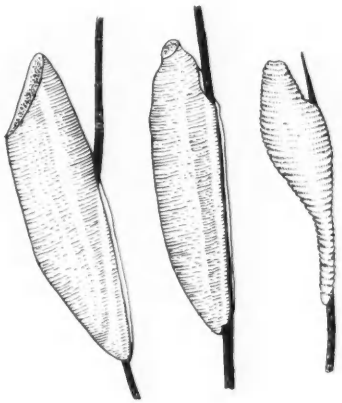
OFFSPRING

The offspring of some kinds of parasitic animals cannot survive outside their hosts. The zoologist finds much interest in the various ways in which such parasites pass from one host to another without even entering the outside world. Let us consider the human malarial parasites as an example. They live inside the red blood cells of man and eventually destroy these cells; but before they destroy them they each split up into 20–30 smaller individuals, each of which may attack another red blood cell. Each time they split up they release into the blood substances which cause what we call an attack of malaria. Eventually, however, the parasites can no longer multiply their numbers in this way. They then become male and female individuals (gametocytes). If now a mosquito sucks up human blood, all the malarial parasites except the male and female individuals are digested and killed in the mosquito's stomach. The males and females, however, survive and go through a sexual process inside the body of the mosquito which produces millions of minute, spindle-shaped individuals (called sporozoites), which pass to the mosquito's salivary glands. When the mosquito again sucks human blood, the sporozoites are transmitted back into man, and the cycle begins again. Throughout this life cycle, therefore, the malarial parasite lives inside the body of either the mosquito or man: it never once enters the world outside these two hosts;

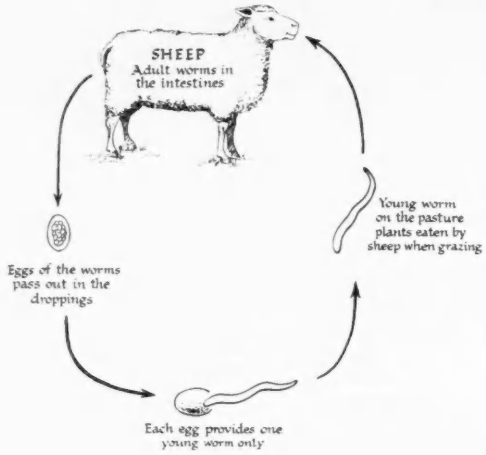
Eggs of a warble fly attached to one of the hairs of cattle.



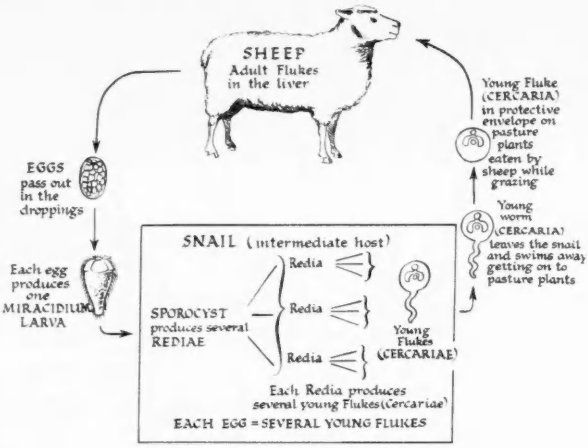
Egg (nit) of a human body-louse.



Eggs of the three common British species of botflies each attached to a hair of a horse.


SHEEP
Adult worms in the intestines
Young worm on the pasture plants eaten by sheep when grazing
Eggs of the worms pass out in the droppings
Each egg provides one young worm only

Life history of the stomach worm of sheep and cattle.


SHEEP
Adult Flukes in the liver
Young Fluke (CERCARIA) in protective envelope on pasture plants eaten by sheep while grazing
EGGS pass out in the droppings
Young worm (CERCARIA) leaves the snail and swims away getting on to pasture plants
SNAIL (intermediate host)
Each egg produces one MIRACIDIUM LARVA
SPOROCYST produces several REDIAE
Redia
Redia
Redia
Young Flukes (CERCARIAE)
Each Redia produces several young Flukes (Cercariae)
EACH EGG = SEVERAL YOUNG FLUKES

Life history of the liver fluke of sheep and cattle.

if it did, it would very quickly die. The human malarial parasite has one further problem to overcome. It cannot live and develop inside any kind of mosquito. It can live and develop only in mosquitoes belonging to the genus *Anopheles*; and only in the *females* of this genus, because only the females suck human blood.

In contrast to such parasites which cannot survive in the world outside the host, there are many others which produce, while they are inside a host, phases of their life histories which can survive in the world outside the host. These phases are specially adapted to life in the outside world, and do not show parasitic dependence on a host. Their function is to make contact with a new host and then to infect it. For example the common stomach worm of sheep and cattle (*Hæmonchus contorus*), produces, while it is parasitic in the fourth (true) stomach of these animals, fertilised eggs which pass out on to the pastures in the hosts' droppings From these eggs come young worms which live on bacteria that thrive in the droppings. These young worms must pass through three phases before they can live again in sheep and cattle. First comes what is called the *first larva*, which hatches out of the egg. This feeds on bacteria and grows and moults its skin to become the *second larva*; this also feeds on bacteria and grows and moults its skin to become the *third larva*. It is this phase (which is reached 3–7 days after the egg first hatched) that infects the new hosts. The third larvæ wriggle up the pasture plants and are eaten by sheep or cattle when these animals crop the pasture plants. Reaching the fourth stomach in this way, the larvæ become parasitic there, and grow, after two more moults, into the adult male or female worm. In this life history, it is only the third larva which can infect the new host. If the first or second larvæ are eaten by sheep or cattle, they are killed in the host's food canal. As it takes 3–7 days to produce the third larvæ, sheep and cattle can be protected from infecting themselves with third larvæ derived from their own droppings by the simple method of moving them every few days on to new pastures.

When a parasite goes through such a life cycle involving a parasitic and a non-parasitic phase, it must meet and overcome during its non-parasitic phase the risks of life outside its hosts. How is this achieved?

First let us take a look at the fertilised egg of the parasite, for this is frequently the phase that first meets the injurious effects of the world outside the host. The eggs, the moment they leave the body of the host where they are produced, are exposed to such climatic influences as drying (always a formidable risk), cold, heat, rapid changes of temperature and the damaging effects of the direct rays of the sun. These can destroy countless numbers of fertilised eggs, and many others are eaten by animals inside which the parasite cannot live; in the latter event the eggs are digested and destroyed in the alimentary canal of the animals that swallowed them. These risks can be countered to some extent by the production of large numbers of fertilised eggs, and this is no doubt one reason why some parasitic animals—though by no means all of them—produce enormous numbers of fertilised eggs.

The large roundworm of man and the pig, *Ascaris lumbricoides*, can, for instance, produce 200,000 fertilised eggs a day and it has been estimated that, in China, where American workers found that 355 million people were infected with this worm, the total weight of eggs produced each year by these worms was about 18,000 tons—a remarkable figure when we reflect that each of the eggs is only about 1/500 inch long. Incidentally American workers have found that this worm, which occurs in all parts of the world, was present, in 1947, in about 644 million people of various nationalities. Some tapeworms are also prolific producers of eggs. Thus the huge fish-tapeworm of man, which may be 60 feet long, may produce 36,000–1,000,000 eggs a day; the beef tapeworm may produce some 50–150 million

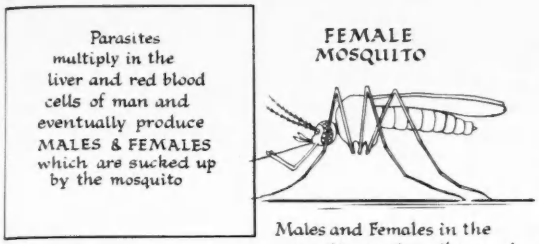

Parasites multiply in the liver and red blood cells of man and eventually produce MALES & FEMALES which are sucked up by the mosquito
FEMALE MOSQUITO
MAN
Males and Females in the mosquito produce thousands of young that are injected back into man

Diagram of a malaria-carrying mosquito sucking human blood.

eggs a year. Other parasitic worms do not, however, produce eggs on this scale. The egg-production of some of them is relatively small, although it still remains of the order of thousands rather than hundreds a day. Some parasitic arthropods also produce considerable numbers of eggs. The female castor-bean tick, so common on British sheep and other hosts, lays 500–2000 eggs before she dies. She does this, however, only once, namely at the end of the life cycle, which in this species lasts three years in Britain. Among parasitic insects egg-production is relatively small, each insect producing, during its lifetime, only a few hundreds of eggs; in some cases the figure is very much smaller.

Chances of survival are increased if there is a resistant envelope to shield the contents of the egg from heat, frost, drying and other injurious influences. The illustration of the egg of a whipworm shows this. The eggs of the large roundworm of man and the pig are so well protected by their thick shells that they can survive outside the host for as long as five years. They can even withstand passage through a sewage farm and, when the effluent from such a plant is used, as it has been used in some German and Russian cities, to water land growing salad plants, the live eggs of this worm may get on to the salad plants and may be swallowed by humans.

Many other examples of egg protection could be given. One of the most remarkable is provided by the castor-bean tick; the female tick carefully covers each egg with a protective coating of wax. The waxing is partly done inside the womb of the tick before the egg is laid; but, as each egg leaves her body, the mother tick bends down her head and pours, from a horned bladder that comes out of her head, an additional coating of wax over each egg. Then, bending back her head again, she tosses the egg over on to her back. In this way she may eventually become almost buried under the mass of eggs that she has laid.

The eggs of some species of parasitic animals get a better chance of survival because the female lays them in situations where they are kept warm and where the young parasites that hatch out have good chances of establishing themselves inside or on the surfaces of the

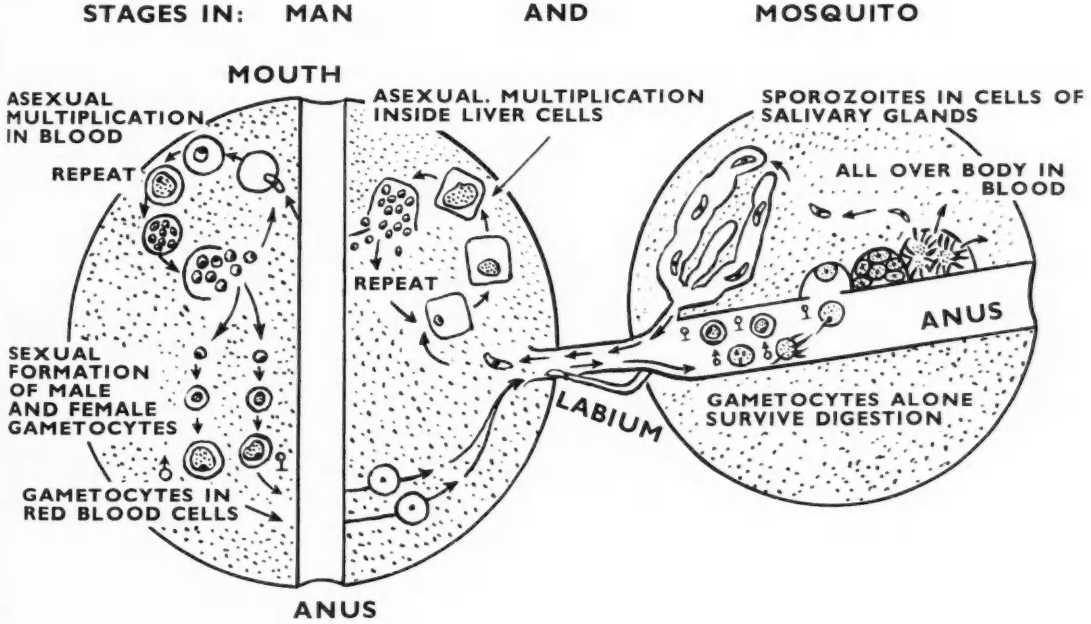


Diagram of the life history of a human malarial parasite.

bodies of their hosts. Thus we find that lice glue their eggs (commonly called "nits") to the hairs of man and their other hosts.

More remarkable are the female warble flies, which glue one or more eggs to a single hair of the cattle which are their hosts. The grubs of these flies hatch out and bore their way through the skin of the cattle to live, inside the host, a parasitic life which lasts from the summer or autumn of one year until the following spring. During the months of parasitic life, the grubs of the warble flies grow up and make their way to the skin alongside the backbone of the host and there they cause the formation of swellings, or warbles, inside which the grubs become mature. Then the grubs make their way out of the warbles and drop on to the ground, where each becomes a pupa. The adult fly emerges from the pupa in early summer. The first adult warble flies are to be seen in late May or early June.

It is interesting to notice that the eggs of warble flies are glued nearer to the bases of the hairs than to their tips. In this situation they are kept warmer, and the young grubs have not so far to go to reach the skin of the host. In contrast to this, the eggs of the horse botflies, so commonly seen as yellowish-white specks on horses' hairs, are glued nearer to their tips. This is no doubt associated with the fact that the grubs of botflies do not enter the bodies of horses by penetrating the skin, but by being swallowed by the horse; and with the further fact that the eggs of some species of botflies hatch quicker if they are licked by the tongue of the horse. The remarkable manner in which the female botflies and warble flies glue their eggs to the hairs of their hosts while the female insect is on the wing is one of the marvels of animal life. Not less interesting is the manner in which one species of the warble flies will stalk and follow cattle until they get a chance to perform this egglaying miracle. These flies, like the horseflies, hum as they fly about and cattle often gad about in their efforts to avoid them, as if they were alarmed by the hum; and, as farmers know well enough, the cattle may injure themselves when they are running about in this way. They are not, however, trying to avoid the bites of these flies; both warble flies and botflies are unable to bite or suck blood, because their mouthparts are so degenerate that they cannot feed at all.

Some insects whose grubs are parasitic lay their eggs actually inside the bodies of the hosts in which the grubs live and develop. These hosts are often the grubs of other insects. In some instances the parent of the parasitic grub will, before she lays an egg, investigate a likely host to find out whether another egg has already been laid inside it. If she finds that this has happened, she will leave that host and proceed to look for another one which is, so to speak, not already occupied.

Remarkable as these methods of protecting the offspring are, they are excelled by the habits of parasitic animals which protect their eggs inside their own bodies until the offspring have hatched out and have developed to an older stage. The tsetse flies, for instance, nourish their larvæ in their wombs, feeding them from "milk glands" until they are ready to turn into the chrysalis stage. The female tsetse fly then gives birth to the mature grub and places it immediately in a sheltered place, such as under the bark of a tree or in warm, moist soil. Here the grub turns almost at once into a chrysalis, which is enclosed in a hard protective case inside which the adult insect develops. This habit considerably lessens the risks to which the offspring of these tropical flies are exposed, and to it the successful survival of these remarkable African flies is probably largely due.

If we leave now the eggs and consider more especially the offspring that come out of them, we find that a further method of increasing the chances of infecting a new host is, not the production of large numbers of eggs, but the increase of the number of infective phases of the parasite that are derived from each egg. The production of large numbers of these infective phases also helps the parasite to make, so to speak, a mass attack on the host. The host's resistance to the parasite may in this way be relatively easily overcome. The way this works may be explained by comparing the chances of, say, a roundworm (e.g. the stomach worm of sheep and cattle) and those of the liver fluke, which also infects sheep and cattle. As the figure of the life history of the stomach worm shows, each egg of this species can produce only one adult worm. To infect itself heavily, therefore, the sheep or cow must swallow a number of individual infective larvæ, each of which must succeed in establishing itself inside the sheep or cow. The rate of infection of the sheep or cow will therefore be relatively slow. If we look now at the illustration of the life history of the liver fluke, we see that each of its eggs may produce more than one adult fluke. From each egg comes a single, pear-shaped larva called a *miracidium*, which enters, and becomes parasitic in, a particular species of snail. Inside the snail, however, each miracidium becomes a reproductive sac called a *sporocyst*, which produces several worm-like larvæ called *rediæ* and these in turn are capable of multiplying and produce more rediæ. Then each redia produces several young flukes, which have tails and can swim. These young flukes are called *cercariæ*, and it is these that infect the new host. Thus we see that from a single egg a number of cercariæ can develop. The cercariæ leave the snails and get on to the pastures and there enclose themselves inside protective envelopes, inside which they wait until they are eaten by a sheep or a cow or a rabbit or other host in which the adult fluke can live. Each fluke is hermaphrodite, and this hermaphroditism further increases the fluke's chances of survival. Against its chances is the need for two different kinds of hosts, the snail and the mammalian host. But the habits of the snails involved are such that they are likely to set free the infective cercariæ in situations in which they are likely to be swallowed by the mammalian hosts.

Many other parasitic animals use this kind of device for multiplying the number of potential adults derived from each fertilised egg. Too numerous to mention are the many other ways in which parasitic animals increase their chances of entering new hosts, but one method of doing this is so important that it deserves to be

described. This is the method developed by some kinds of parasitic animals of entering the host, not through its mouth, which is the portal of entry used by most parasitic animals, but through its skin. The young of the hookworms of man, cattle and other animals, for instance, and those of some flukes, can bore their way through the skin of their hosts. This ability undoubtedly increases their chance of infecting their hosts. The human malarial parasites already mentioned also, of course, enter the host through the skin, but they fall into a different category because they can only do it with the help of another parasite, the mosquito, upon whose aid they entirely depend.

This reminds us of the many instances of one parasite helping another to enter its host. One example is interesting because it shows us the use by a parasitic animal of the hitch-hiking principle. In Mexico and the Argentine man, and cattle also, may be the victims of a fly related to the warble flies of cattle and the bot-flies of horses. The grubs of this fly get into human skin, in which they become parasitic until they are ready to turn into the chrysalis stage. But how do they get into human skin? The female fly does not glue her eggs to the hairs of the hosts as the female warble flies of cattle do. She glues them instead to the abdomen of a beautifully coloured mosquito which is a voracious sucker of human and other blood. When the mosquito visits man and cattle to suck their blood, the grubs in eggs attached to the mosquito's abdomen hatch out and penetrate into the skin of the man or cow.

It is not possible in a short article to consider what are, to some observers, the most remarkable and complex of the adaptations shown by parasitic animals, namely, the correlations of their life histories with the life histories of the hosts. However, I hope I have been able to make it clear that the parasitic animal is, in its biological relationships, not so very different from animals that live in other ways. There is little ground for despising it. The parasites are, in fact, among the most interesting, remarkable and efficient of living things. If the parasite causes incalculable illness and suffering in man and other animals, this harm that it does represents a danger, an added risk, rather than a gain, from the point of view of the parasitic animal. All the pain and illness caused by parasitic animals is, in fact, the result of faulty adaptation between the host and the parasite and this is, as a rule, rectified in time by the process of evolutionary adjustment. It may be true, in fact, that this slow process of gradual adaptation of host and parasite to each other has brought into existence some instances, at least, of that mutually beneficial association called symbiosis, in which two different species live together, not in discord, but in physiological co-operation. Certainly there are many parasites and hosts that live together so harmoniously that their state of life is not very far removed from this.

TWENTY-FIVE YEARS AGO

FILMS IN THREE DIMENSIONS

F. de la C. Chard, B.Sc., in the November issue for 1932, discussed the problems of producing three-dimensional films, a task still unsolved today. First he described a method of separating the alternate right- and left-eye pictures, by means of the "analglyph", invented by M. d'Almeida and M. Ducos. This required the left-eye pictures to be coloured red, and the right-eye picture green, while the spectator wore a pair of tinted glasses of which the left-eye glass was red and the right-eye glass green. After a few seconds all sense of the colours was lost and a grey image was seen stereoscopically. The disadvantages of the method were that the film of alternate red and green pictures would be expensive and the amount of light traversing such a film comparatively small; this resulted in a very dull, lifeless picture. Moreover, it was probable that continued use of the anaglyph spectacles would make cinema-goers permanently colour blind.

Mr Chard then described another method which is also still experimental today. It was suggested by J. Anderson to use polarisers and analysers of plates of thin glass at the polarising angle. Again alternate pictures were projected on the film with two beams of light polarised at right angles to each other. The polarising screen was rotated backwards and forwards by a claw movement through 114°, since the transmitted and reflected beams were both polarised at right angles to each other.

The disadvantages were again the amount of light absorbed by the polariser, and the fact that the picture had to be viewed through an analyser. The right- and left-eye images did not have the same brilliance, and the picture had to be projected on a polished or metallic surface since a rough surface depolarises the light.

Other possibilities, said the author, arise from the fact that the eyes are the most gullible parts of the human being. In the cinema at this time they are deceived about twenty times per second, and the author added, there may be means of carrying the deception still further. If an object is lit alternately, first from one side and then from the other, it gains an appearance of solidity which, as far as foreground objects are concerned, almost amounts to stereoscopy. The difficulty so far has been to provide a sufficiently powerful, rapidly flashing light that could work synchronously with the camera. In spite of twenty-five years of work on this problem, no single solution is yet generally accepted.

GAS CHROMATOGRAPHY

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For the most part the chemist is interested in the preparation and properties of pure substances. Nature, on the other hand, seems to regard pure substances with something akin to her proverbial abhorrence of a vacuum, and almost always produces mixtures. This is so even within the limited confines of laboratory and industrial syntheses, but it is most manifest in connexion with the chemical substances which are produced by living systems. The chemical complexity which is characteristic of all living organisms may provide the explanation for the historical fact that one of the simplest and most powerful general methods for separating chemical substances—chromatography—was discovered by a botanist (Michael Tswett, 1906), while what is probably the simplest and most powerful of chromatographic techniques—gas-liquid chromatography—was suggested (Martin and Synge, 1941) and developed (Martin and James, 1952) by biochemists.

Gas-liquid chromatography, and to a lesser extent gas-solid chromatography, are now being used extensively for the separation of complicated mixtures of vaporisable substances, and at the same time they allow direct identification and quantitative analysis of each of the separated components. Hitherto the most widespread application has been in the petroleum industry, but the techniques are also finding considerable use with such diverse chemical species as solvents, perfumes, inorganic hydrides, coal-tars, organic fluorine compounds, the fatty acids of human sebum, and the taste substances of the strawberry, to mention but a few examples. The techniques require simple and inexpensive apparatus and small (1 to 10 milligrams) samples. They are extremely rapid, an analysis of a twenty component mixture being possible in half an hour.

PRINCIPLES

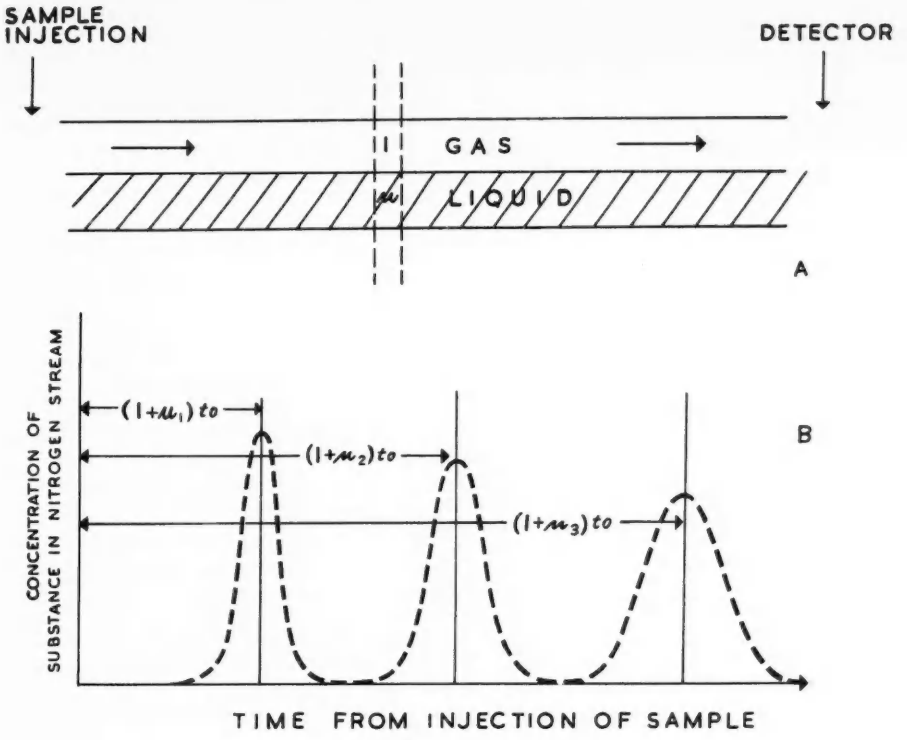
If we have a system consisting of two immiscible phases (such as oil and water) and we introduce into this system a mixture of two substances, then we shall in general find that one of the substances becomes relatively more concentrated in one phase, and vice versa in the second phase. If the difference between the two substances is acute (as would be the case for example with salt and wax in our oil and water system), then their separation may be effected in one operation, but if the difference is small we can still effect the separation by repeating the distribution process many times. Chromatography provides a mechanism for doing this, by holding one of the phases fixed in a column, and passing the other phase through the column. Tswett used a two-phase system consisting of a solid adsorbent held in the column, and a liquid solvent flowing through the column. He used the method to separate the pigments of green leaves, and observed this by the appearance of different coloured bands on his column. He therefore called the method chromatography. Today the method has been so extended that it is more usual to apply it to colourless substances, but the name remains, perhaps as a happy compliment to its originator whose name is a Russian word for colour.

In gas chromatography one of the two immiscible phases is a gas, and this is made to flow through a column which may contain a solid adsorbent (gas-solid chromatography) or a liquid phase supported as a thin film on an inert solid (gas-liquid chromatography). The use of a moving gas phase as opposed to a moving liquid phase (liquid chromatography) introduces important advantages. There is usually a rapid exchange of molecules between a gas and either a thin liquid film or a solid surface, which means that rapid separations ar possible. Gas viscosities are low so that long, and corre spondingly more efficient, columns may be used withou creating impossibly large resistances to flow.

The underlying principles of gas chromatography can be illustrated by considering the idealised gas-liquid column which is shown in Fig. 1*A*. This consists of a tube containing an involatile liquid (for example liquid paraffin) uniformly distributed along the tube, and above which there flows a stream of gas (for example nitrogen) at a constant flow-rate. We now rapidly inject into the gas stream at the beginning of the column a small sample of the mixture we wish to separate and analyse. In any one cross-section of the column, a given substance will distribute itself between the moving gas and the fixed liquid, such that there are say μ molecules in the liquid on the average for every one molecule in the gas phase. For a substance which is itself a permanent ga (for example hydrogen) μ will be negligibly small, so tha it travels through the column at the gas flow-rate, anc will emerge at the end of the column at a time t_0. We can measure this time by using a detector instrument sensitive to changes in gas composition. Other substances for which μ is appreciable will take longer to pass through the column, for they will only move forwards while they are in the moving gas and they will be in the gas phase on the average only a fraction,

$$\frac{1}{1+\mu},$$

of the time. Their average emergence times (called retention times) will therefore be $(1+\mu)t_0$, where μ will vary from substance to substance. Retention times are represented for three different substances by the vertical lines of Fig. 1*B*. Real molecules for a variety of reasons (such as gas diffusion along the column, non-equilibrium between gas and liquid phases, and the fact that gas in a real column will flow through a number of different channels) are distributed about the average times to produce a series of peaks, one for each substance. These



FIGS. 1*A* and 1*B*.

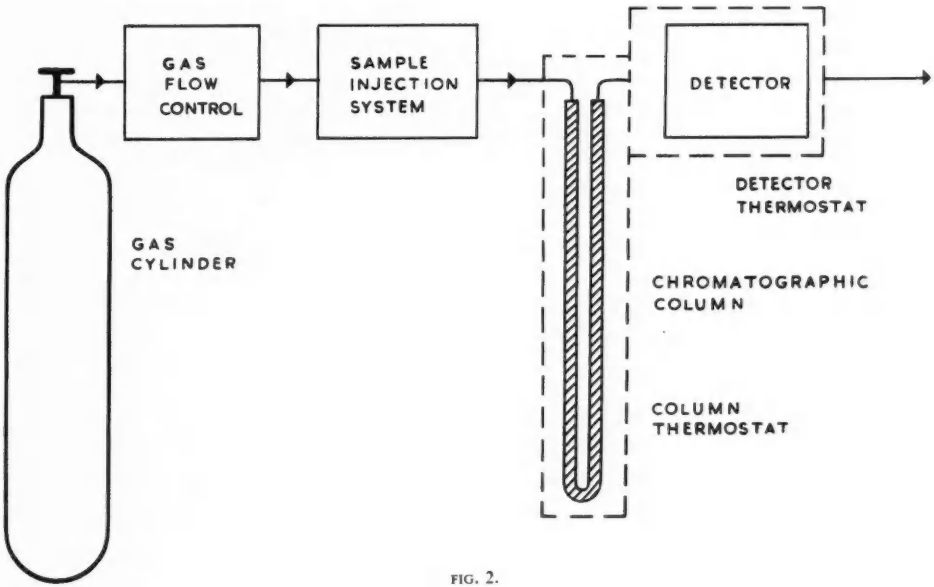


FIG. 2.

peaks are represented by the dotted lines in Fig. 1*B*, and usually they are very nearly symmetrical about the retention times.

In gas-solid chromatography the situation is a little more complicated, for the value of μ will vary not only from substance to substance but also with different quantities of the same substance. This is because molecules have to compete for a limited number of places on the surface of the solid adsorbent. The result normally is to produce peaks (Fig. 3*D*) which have sharp leading and diffuse trailing edges.

APPARATUS

Fig. 2 illustrates a typical experimental arrangement for gas chromatography. The flowing gas is taken from a cylinder via a flow-regulating valve and passes in turn through a sample injection system, the chromatographic column, and the detector. Many injection systems have been devised, but one which is commonly used consists of a self-sealing rubber cap through which a hypodermic needle may be forced, and the sample is then injected from a syringe without interrupting the flow of gas. A typical column will be constructed from a 2-metre length of 4-millimetre internal diameter tubing. Longer columns are used for difficult separations, and wider columns are used for larger samples. The tubing may be of glass or metal, and is usually bent or coiled so as to limit the size of the thermostat which controls the column temperature. The column and detector thermostats are often the same. A gas-liquid column may be packed with a mixture of kieselguhr or crushed brick (which act as inert supports) impregnated with about 20% by weight of the column liquid. The impregnation and packing techniques are so devised as to give a thin liquid layer, so that there can be a rapid exchange of sample molecules between the gas and liquid phases. A gas-solid column will be packed with particles of an adsorbent solid such as charcoal, silica gel, or activated alumina.

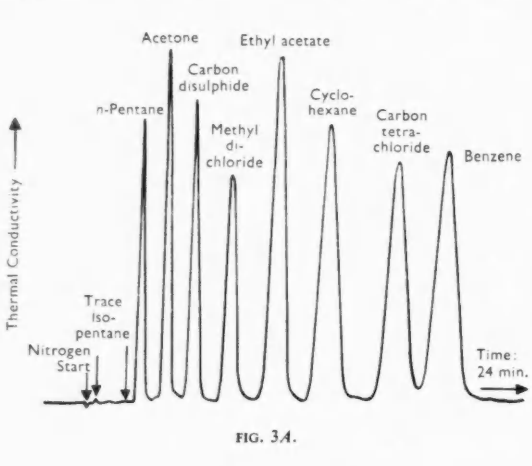


FIG. 3*A*.

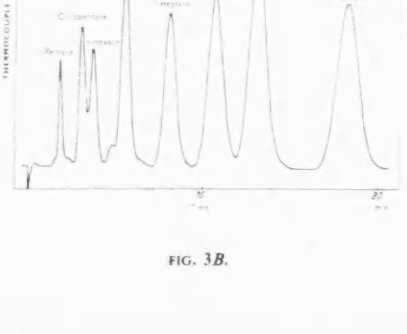


FIG. 3*B*.

The most crucial part of the apparatus is the detector, which senses and measures the concentration of the sample substances in the gas stream flowing from the column. The detector must respond rapidly to changes in sample concentration, have a high sensitivity (that is, produce a recognisable signal for concentrations of the order of 1 molecule of sample substance to 100,000 molecules of gas), and if possible it should have a signal output which is directly related to some simple property of the sample substances, such as number of molecules or number of grams. The output from the detector is usually fed directly to an automatic recorder which draws a series of peaks (a chromatogram) on a rotating roll of paper. Chromatograms obtained in this way are illustrated in Figs. 3*A–D*. The design of detectors for gas chromatography has proved to be a popular subject, and among the ingenious methods which have proved successful are those depending on automatic titration of the sample substances, absorption of the carrier gas (CO_2) and volume measurement, thermal conductivity, ionisation by beta-rays, measurement of the heat produced when the substances are burnt in a hydrogen flame, combustion and infra-red analysis of the resulting CO_2, gaseous discharges and on gas density measurements. Thermal conductivity has so far proved to be the most popular. In this method the gas leaving the column passes through a tube in the centre of which there is an electrically heated wire (or thermistor bead). The heat conducted away by the gas is a function of its composition, which is thus reflected in the resistance of the wire. The wire is made to form one arm of a Wheatstone bridge circuit, and the out-of-balance voltage of this is fed directly to the recorder.

EXPERIMENTAL RESULTS

The type of results which is obtained by gas chromatography is illustrated by the chromatograms reproduced in Figs. 3*A–D*. Fig. 3*A* is a chromatogram for a mixture of solvents, *B* for a group of hydrocarbons, *C* for a series of high-boiling aromatic derivatives, and *D* for a gas mixture. In the cases of *A*, *B*, and *D*, the columns were operated at relatively low temperatures (between room and 100°C), but for *C* it was necessary to use a column temperature of about 300°C in order to achieve a sufficient volatility of the sample substances. In each example a different detector was employed, in *A* a thermistor-type

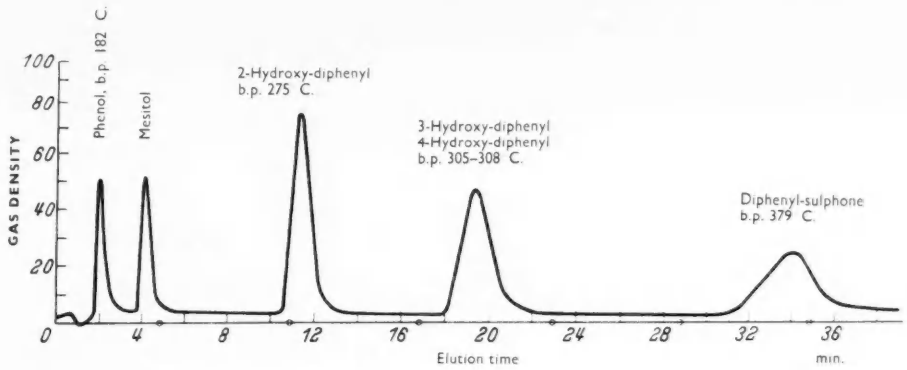


FIG. 3C.

thermal-conductivity cell, in *B* the hydrogen-flame detector, in *C* the Martin-density balance, and in *D* a hot-wire thermal conductivity cell. *A*, *B*, and *C* are the results of gas-liquid chromatography, while *D* was produced by gas-solid chromatography. Gas-solid chromatography is particularly useful for such low-boiling materials as gases, and for certain specific separations where a highly selective adsorbent (such as molecular sieves) may be used. Gas-solid chromatography using palladium as the column material has proved successful in the separation of hydrogen and deuterium. A modification of the gas-solid method, called displacement analysis, is of value for the concentration of trace materials.

For gas-liquid chromatography the retention time of each substance depends directly upon its distribution coefficient (μ) between the gas and the column liquid; this time is therefore characteristic of the substance and can be used to identify it. Retention times hitherto have usually been obtained by running through the same column a series of pure substances which it is suspected are present in the mixture. A serious effort is now being made, however, to collect standardised retention times, and soon it should be possible to identify an unknown substance in a mixture by reference to published tables. Characterisation of a substance by means of a retention time has a great advantage over such traditional methods as determination of melting point, boiling point, or refractive index, for the result is virtually independent of the purity of the sample. Furthermore an additional check may be made by comparing the retention times for a substance with two or more different column liquids, for the changes in retention time on passing from one liquid to another can be very sensitive to the chemical nature of the substance. This effect is illustrated by the results which have been plotted in Fig. 4 for two column liquids, liquid paraffin, and the aromatic liquid benzyl-diphenyl.

Quantitative analysis is performed by measuring either the area under each chromatogram peak or peak heights. The exact procedure used will depend upon the characteristics of the detector. In general an accuracy of better than 1% is obtained relatively easily.

In certain circumstances it will happen that two substances have such similar retention times that they will produce only a composite peak. To improve their separation two courses are open. In the first the column packing, column length, gas flow-rate, and so forth are modified in such a way as to produce a decrease in the spread of the peaks about the retention times. This procedure is said to increase the theoretical plate number of the column. In the second the column liquid (and/or temperature) is changed until the two substances have sufficiently dissimilar retention times. Fig. 4 will indicate how this may be done.

APPLICATIONS

Gas chromatography has already become a routine analytical tool in many chemical industries. Modern gas chromatographic instruments are now being produced which will act completely automatically on an industrial process, taking samples at regular intervals, injecting them into the column, and displaying the analyses as a continuous record.

In the academic laboratory it is rapidly becoming a standard analytical technique particularly in organic chemistry. It is also finding use as a method for the preparation and purification of materials on the 1 to 10-gram scale. It has possibilities as a production method for those chemicals which are required in small quantities but in a very pure form. Gas chromatography is also of value in the analysis of such inorganic volatile substances as the boron and silicon hydrides, especially as all the operations may be carried out in an inert atmosphere. Future work with high-temperature columns may make the method applicable to the analysis of metals and metal salts. The physical chemist has used gas chromatography as an analytical tool, particularly in connexion with studies of reaction kinetics, but one hitherto little-developed application is to turn the technique in reverse and to use retention times for the study of physico-chemical equilibria such as are involved in

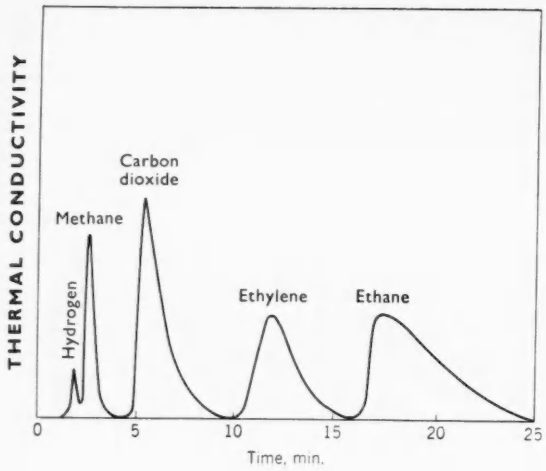


FIG. 3*D*.

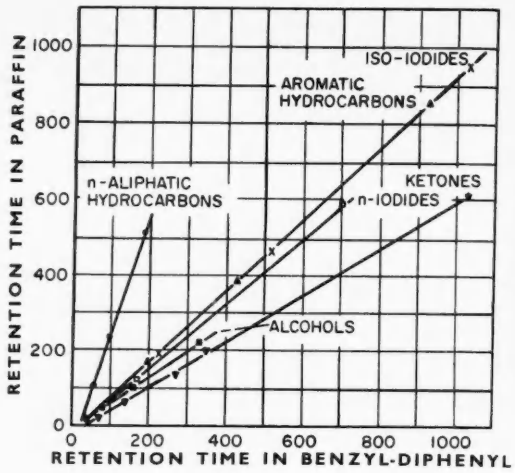


FIG. 4.

solution, complex-ion formation, and adsorption. Here gas chromatography offers simplicity of apparatus, rapidity of experimentation, relative independence of sample purity, and high quantitative accuracy. In the biological sciences gas chromatography makes possible a far greater understanding of the rôle of chemical substances in living systems.

REFERENCES

Phillips, C. S. G., "Gas Chromatography", London, Butterworths, 1956.

Keulemans, A. I. M., "Gas Chromatography", New York, Reinhold, 1957.

Desty, D. H. (editor), "Symposium on Vapour-Phase Chromatography", London, Butterworths, 1957.

NEW WATCHES AND CLOCKS

Today, when accurate, reliable, and cheap time-pieces are mass-produced, novelty is found in catering for specialised needs and in scientific curios. Examples of both were shown at the International Watch Fair held in London during September. Perhaps of greatest interest to scientists and engineers was an entirely anti-magnetic watch, shown by the International Watch Company of Schaffhausen and claimed to be fully protected against magnetic influences up to 1000 oersted/gauss. This has been achieved by enclosing the complete movement, itself made of many anti-magnetic parts, in a special inner case of soft iron composition. It should prove useful to those who have to work in high-voltage laboratories and atomic research laboratories, as well as to engineers in industries where strong electric currents are used. Appropriately, the watch is called "Ingénieur".

Patèk Philippe's "Light Clock" is a scientific curio. A photo-electric cell, exposed each day during a minimum of four hours to an illumination of 200 lux, produces a small current which is stored in an accumulator; fed by this accumulator, a small electric motor automatically winds the clock five times a day. The retail price of this clock in London is £450. Interesting also is the use of transistors in the Kundo electric clocks, driven by dry cells; the reduced current consumption of the transistors, as compared with previous components, allows an uninterrupted running of the clock of five years instead of three. Will the watch of the future be transistorised and use light as a source of power?

Special anti-magnetic protection is provided by the inner mantle which envelops the entire movement and comprises the cover (1), the ring (12), and the bottom (14). The bottom of the outer, rust-free stainless steel case (13) is bolted down and features the first sealing ring (11). A second sealing ring (10) is inserted between the centre of the case and the inner mantle (12). These sealing rings are made of elastic, acid-proof plastic, and provide protection against water, moisture, and acids. A shatterproof, synthetic crystal (2), surrounded by a glass ring (4), and reinforced by a steel ring (3), ensures a watertight seal. The winding crown, slightly recessed in the case centre, is sealed by two rings. The first sealing ring (6) is in the head of the winding crown; the second (9) is between the crown neck and case centre.

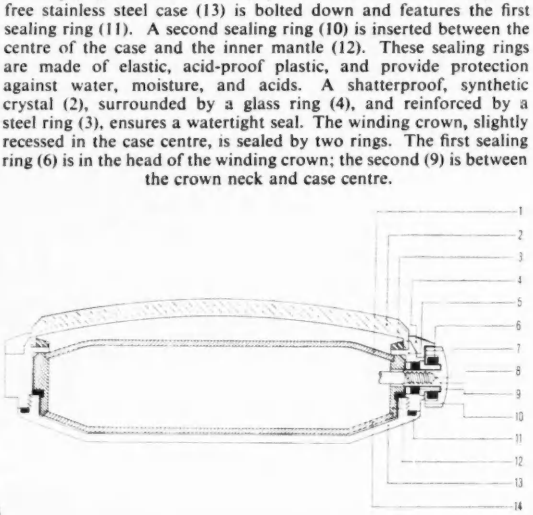


FIG. 1. Loading air-dried Laminaria stems. S. Uist.

SEAWEED AS A SOURCE OF CHEMICALS

J. GORDON COOK, Ph.D., F.R.I.C.

Every year, millions of tons of seaweed are tossed up on to the rocky coastlines of the continents. These primitive plants are different from the plants we grow as crops on land; they are algae, the water plants responsible for food production in the sea. Inside their simple body-structures, seaweeds and other algae carry a concentration of minerals and organic substances that are becoming steadily more important as industrial raw materials.

The ability to concentrate sea-water minerals made seaweed into a source of raw materials during the early days of the chemical industry. Seaweed was gathered in huge quantities around the coasts of Britain, and in Ireland, France and other countries. It was burned to provide the ash which is known as kelp; in this kelp were mineral salts that the seaweed had absorbed from the sea. The organic substances of the plant were burned away during kelp manufacture, disappearing as carbon dioxide, water, and other gases into the air. During the 18th century, kelp-burners provided the alkali salts that were needed by the soap and glass industries. So great was the demand that Scottish kelp-burners could not keep pace. Kelp reached a price of £20 a ton, and the export of salts from the Hebrides at one time amounted to nearly half a million pounds' worth a year.

By the early 19th century, the inevitable had happened. The development of a synthetic process for making soda knocked the bottom out of the kelp market and by 1840 the demand for seaweed-soda had almost died away.

Meanwhile, kelp had been given a new lease of life. During the Napoleonic wars, the British blockade stopped supplies of saltpetre reaching France. Bernard Courtois made saltpetre by reacting calcium nitrate with soda from kelp, followed by conversion of the sodium nitrate into potassium nitrate. On cleaning his chemical plant with sulphuric acid he found that a purple vapour condensed to form beautiful metallic-looking crystals on the cool parts of the vessels. This was iodine, which had come from the kelp used as a source of alkali.

By the middle of the 19th century, iodine production based on kelp was a flourishing industry, and we find that there were twenty iodine factories in Glasgow alone. But again disaster threatened. During the 1880s, iodine was obtained as a by-product from Chile saltpetre; soon it was ousting seaweed iodine from many of its most important markets. Since then the production of iodine from seaweed has declined, but kelp-burning has remained active in a few regions of the world today. Iodine is still being extracted from kelp in France, Ireland, and Japan.

Seaweed is now only of minor importance as a source of inorganic materials. But it has once again become a raw material of great value; this time, it is the organic substances of the plant that are in demand.

Though seaweeds live in water, they depend upon the same materials as land plants for their nourishment. In the land plant, carbon dioxide and oxygen are supplied by air that permeates the leaves and tissues; water is drawn up from the soil, carrying with it the nitrates, potash, phosphates and other minerals needed by the plant. Seaweeds, however, derive all their material needs from the sea-water in which they live; carbon dioxide and oxygen are dissolved in the water together with the other essential plant foods. Inside the cells of the seaweed, these simple chemicals are built

up into complex substances with the help of chlorophyll,* which absorbs the energy required to support these syntheses from sunlight. Like land plants, the seaweeds manufacture carbohydrates, proteins, fats, and other substances involved in the processes of the living cell.

There is an overall similarity between the chemical processes of the seaweeds and those of the ordinary land plant. But the details of the manufacturing routines differ in a number of ways. The end-products are related to those of the land plant, but they are not the same. Nor does one type of seaweed manufacture the same structural materials as another.

At the present time two groups of seaweed are of economic importance as industrial raw materials—the brown algae and, to a much smaller extent, the red algae.

The brown algae range from tiny filamentous plants to the giant kelps that are amongst the largest plants on earth; some seaweeds growing off the coast of Tierra del Fuego reach up through the water to a height of 600 feet or more. The structural material in these plants is a carbohydrate called alginic acid. This substance does a job that is similar to that of cellulose in the land plant; it is the strength-provider. Alginic acid, which resembles cellulose in chemical structure, has become the most important of all the organic substances that we derive from seaweed.

Alginic acid was discovered in seaweed in 1883 by a British pioneer of the seaweed industry—E. C. Stanford. Stanford was an enthusiast, who made a whole-hearted attempt to establish an industry based on the substances he found in seaweed. At first, Stanford was concerned mainly with the established processes; he tried to improve the methods used in extracting iodine, and invented better ways of processing the kelp. But Stanford came to realise that the real future of seaweed lay in the organic material that was burned during kelp manufacture. He made a study of the organic substances in seaweed, and in 1883 discovered alginic acid in the brown algae that grow so prolifically off the rocky Scottish coast. Alginic acid is insoluble in water, but is converted easily into a soluble sodium salt; Stanford extracted alginic acid by boiling seaweed with soda. The solution of sodium alginate was freed of insoluble residues, and alginic acid precipitated from the purified solution by adding acid.

Sodium alginate, or "algin", is a gelatine-like substance. It has extraordinary "thickening" powers; a 2% solution of algin is so viscous that it will only just flow from a bottle. The dried material is odourless, colourless, and tasteless.

Stanford tried to find outlets for his new seaweed products. The market for gelatine-like thickeners was considerable, even in those days. But in spite of Stanford's efforts to develop his new thickening agent, his venture failed. The practical difficulties were overwhelming. Seaweed fresh from the sea is almost nine-tenths water; if it could not be dried on the spot as it was harvested, nine tons of water had to be carried to the factories with every ton of useful material. Stanford's dream of a new type of seaweed industry did not come true. The economics of the project were against him, and the factories in the Highlands were closed down. But his efforts had not been entirely wasted. Stanford had shown that there were potentially valuable organic substances in the weed. He stimulated interest that has been maintained up to the present day. He laid the foundations of our present seaweed industry, which is already making use of the materials from 750,000 tons of weed a year.

During the early years of the present century, information accumulated as chemists continued the study of seaweed. But the revival of the seaweed industry was slow. One firm, the Liverpool Borax Company, began producing alginic acid products in 1910. During the 1920s and 1930s, interest in seaweed chemicals increased steadily, and alginate industries were established in many countries.

By 1941, algin products worth 1½ million dollars were being marketed in the U.S., and the industry has been growing ever since. Much of the algin is used as a thickener for ice-cream.

Brown seaweeds grow in profusion off the Pacific coast, and harvesting is carried out mechanically by boats fitted with underwater cutters. A timetable is followed which enables the weed to grow again after it has been cut. In Britain, there are now four firms producing alginate products; between them they are making more than a quarter of the world output. Only the U.S. alginate industry is larger. *Ascophyllum nodosum*, the most important British seaweed, is gathered on the shores of islands off the west coast of Scotland, on the mainland shore, and in the Orkneys. Alginates are extracted from the weed at factories in Manchester, Stockport, Runcorn, Barcaldine and Girvan. There are also alginate industries in France and Spain, Norway, Chile, and Japan.

Since alginates first appeared on the market in com-

FIG. 2 Spools of soluble alginate yarn, as used as scaffold for weaving ultra light worsted.

* The chlorophyll is often masked by pigments of other colours.

mercial quantities, they have found innumerable uses in the highways and byways of our complex chemical world. Algin has been vulcanised to a rubbery material that can be used for making typewriter rollers; a cheap, non-inflammable wrapping film can be made from it. It has gone into all sorts of foods as a thickener and emulsifier, and into medicines and cosmetics. Algin has been used for water-proofing concrete, for fire-proofing wood and for preventing the formation of scale in ships' boilers. It has an amazing power of binding powders which do not easily stick together; 3 parts of algin mixed with 97 parts of soot will form a cement that sets to a hard mass with excellent heat-insulating properties and this material has been used for lagging boilers.

Seaweed algin is also providing us with plastics and with slimming agents. It is used for preventing bleeding during operations, and for making special surgical gauzes that can be left inside the body to be absorbed after they have done their job. Alginates are making machine-belts and sausage-skins, tooth-brushes and dusting powders.

Like its chemical relative, cellulose, the alginic acid of seaweed can be spun into artificial fibres. A solution of algin is forced through spinnerets into an acid bath; as the filaments emerge, they are converted into insoluble alginic acid or alginates, which can be stretched and processed into a fibre of useful strength. Much experimental work has been carried out on alginate fibres, but they have not yet become of real economic importance for normal textile purposes. They are widely used, however, for achieving special effects in mixtures with other fibres. Alginate fibres can be dissolved from yarns or fabrics after spinning or weaving. Light and fluffy woollens, for example, can be made from loose-spun yarns in which alginate fibres provide the strength that is needed for processing.

Now that brown seaweeds have become an important raw material for the alginate industry, other constituents of these plants are being examined and, where possible, put to good use. In land plants, starch is used as a reserve store of food; but in the brown seaweeds this job is done by a related carbohydrate, laminarin. The sugar called *mannitol* is found inside the cell of brown algae, and in the cell-walls there are cellulose, alginic acid and a polysaccharide sulphate called fucoidin.

At the Institute of Seaweed Research, Inveresk, methods of extracting some of these substances were worked out. Mannitol from British seaweed could be marketed at an estimated cost of £250–£300 a ton. Synthetic mannitol imported from the U.S. sells at about £450 a ton. It is used in the chemical and pharmaceutical industries, and the manufacture of paint.

Laminarin is a water-soluble polysaccharide similar to starch; its industrial uses have not yet been fully explored. It has some medical applications, as a surgical dusting powder and as an anti-clotting agent. Sulphated derivatives of laminarin have been tested in animals and show anti-coagulant activity equal to half that of heparin. Rats and dogs suffered no harmful effects from the use of these laminarin derivatives.

Between them, the three organic substances alginic acid, mannitol, and laminarin make up about 44% of the solids content of a typical brown seaweed such as the ribbon wrack called *Laminaria cloustoni*. Of the remainder, rather more than half consists of inorganic salts and the rest is protein, cellulose, fucoidin, and small amounts of fucosterol, vitamins and pigments.

There are no accurate estimates of the annual world crop of brown seaweed, but it is believed that there are more than 10 million tons of sub-littoral weed growing on the Scottish coast alone (i.e. under water to a depth of about 6 fathoms). It is reasonable to suppose, on this basis, that there must be hundreds of millions of tons of brown seaweed available to the world as a whole. This represents a virtually inexhaustible store of chemical raw materials which is only now in the early stages of exploitation.

Apart from the brown seaweeds, only the red algae have achieved any real commercial importance. These seaweeds grow abundantly in temperate waters, usually at a greater depth than the brown seaweeds.

In the Orient, a jelly-like material, agar, has been extracted from various species of *Gelidium* for hundreds of years. Agar jelly has achieved world-wide fame as the standard medium for growing cultures of bacteria; it is a firm jelly that withstands normal incubation temperatures, and favours the growth of bacterial cultures. Before World War II, Japan made 90% of the world's agar. But when supplies were cut off during the war, Australia, New Zealand, Canada, and the U.S.A. began extracting agar from the red seaweeds growing round their shores. It is now widely used (like algin) in the food industry, doing duty for pectin in jams and for gelatine in meat pies.

A close chemical relative of agar, called *carragheenin*, is extracted from Irish Moss, which is a red alga known to scientists as *Chrondrus crispus*. Several British firms are producing carragheenin from imported Irish Moss, and the product is being used as a stabiliser and emulsifying agent in the food and pharmaceutical industries.

The red algae do not contain alginic acid, laminarin, fucoidin, or mannitol; these typical constituents of brown algae are apparently replaced by the agar or carragheenin. Also, the pigments and sterols in red algae are different from those in brown algae.

Although the world resources of seaweeds are so immense, there are many practical difficulties to be overcome in using them as an industrial raw material on a really big scale. As the demand for seaweed increases, the ancient techniques of gathering cast-up weed from the beaches, or of cutting it by hand-sickle, are becoming inadequate. These techniques are still in general use all over the world. But seaweed, in the future, will be treated as a crop that must be harvested with proper attention to its continued growth.

TOKENS AND TECHNOLOGY

TREVOR I. WILLIAMS

In the latter part of the eighteenth century and again in the early part of the nineteenth the Government of the day failed to provide sufficient copper coinage to meet the needs of tradesmen, industrialists, and others requiring a considerable supply of small change. To meet the shortage, traders took matters into their own hands and a very large number of token coins, mostly halfpennies and pennies, were struck to make good the deficiency. Some hundreds of varieties were struck, and though each circulated within a small area they were in use virtually throughout the kingdom. They present many points of interest to the collector, but in the present context their interest is that many of them carry authentic contemporary illustrations of scientific or technological subjects.

THE FIRST COPPER TOKEN

The first of these copper tokens was struck, appropriately enough, by the Parys Mine Company—one of the biggest copper-producers of the day—in Anglesey in 1787. Many of these show a variety of miners' tools: pick, shovel, windlass, and powder-horn. This company was the biggest single issuer of tokens. They continued to be struck in great numbers until 1797, when a new copper currency was issued: this was struck by Matthew Boulton, who had manufactured many of the tokens at his famous Soho works. The Government issued large quantities of copper coinage again in 1799, 1805, and 1806, and no need for tokens was felt again until 1811, but many were issued between that year and 1815.

These trade tokens showed a profit to their issuers, for from a ton of copper could be made over 100,000 halfpenny tokens—with a face value in excess of £200—for £150, showing a profit of some £60 per ton. Theoretically, of course, these tokens might be presented for redemption: thus one issued by Hull Lead Works in 1812 carries the words, "payable in bank of Eng: or Hull notes by I. K. Picard". In practice, of course, there would be no occasion for them to be presented for payment so long as the issuing firm's credit was good.

At the time in question, forgery of the official coinage was rife, for the legislation against it was almost incredibly weak. Colquhoun, a London police magistrate, in his "Police of the Metropolis", the eighth and last edition of which appeared in 1806, stated that one coiner was well known to have struck within the space of seven years some £200,000 of counterfeit silver coinage. Forged coins to a face value of some thirty shillings could be purchased for one good guinea. "The laws now in being give us no power to seize counterfeit halfpence; either in the hands of the manufacturers or dealers, who keep a kind of open market at their own houses. Of the copper coin, the quantity of counterfeits at one time in circulation might be truly said to equal three-fourth parts of the whole amount. . . ." Naturally, the trade tokens also were forged, and counterfeits of almost every type are known. In addition, tokens were issued in small runs for the benefit of collectors—much as small states now make special stamp issues for philatelists—and some were privately struck for the same reason.

VARIOUS TYPES OF TOKEN

Much more could be said of the interesting light this throws on conditions in Britain at the turn of the eighteenth century, but the tokens themselves claim our first interest. At that period—the beginning of the Industrial Revolution—the introduction of the Newcomen steam-engine in 1712—a great improvement on Savery's engine—had given new life to the mining industry, for it had given miners victory over water, their age-old enemy. Adequate pumping meant that hitherto unattainable depths could be safely reached. It is not surprising, therefore, that mining scenes figure largely on the tokens. A beautiful Cornish penny of 1811 (Fig. 10) shows the typical engine-house of a tin-mine, with the end of the enormous beam of the engine—perhaps forty feet in length—protruding through the wall. On the right is seen a horse-whim, used for haulage from the mine. Where available, however, water-power was still extensively used. Indeed at this time steam-engines were often used in a secondary role, to pump water to provide a head for a water-wheel. Thus, a Tavistock penny of the same year, issued by the Devon Mines (Fig. 12) shows a typical over-shot water-wheel driving pumping machinery. A halfpenny token issued by J. Hilles of Dublin in 1813 ("payable in Bank of Ireland notes") shows a water-wheel driving a two-bank roller in an iron-works.

The greatly increased mining activity resulted, of course, in corresponding development in the industries concerned with the extraction and working of metals. Foundry scenes are frequently met, as, for example, on one issued by I. Morgan of Carmarthen Iron Works. This particular token conveys a great deal of information besides that implicit in the scenes depicted. It states that Morgan had forges at Kidwelly, Whitland, Blackpool, and Cwmdwyfron. Round the edge of the token—a very common feature—it states that it is payable in London, Bristol, and Carmarthen, an indication of the extent of Morgan's business organisation.

A token of 1795 (Fig. 7), "payable at Skidmore's Furnishing Depository, 123 High Holborn", shows on one side the forging of iron in the age-old way by hand hammers on an anvil, and on the other an iron fireplace. By contrast, a 1790 token of the great ironmaster John Wilkinson shows the use of a heavy mechanical hammer, probably driven by water-power (Fig. 8). A fine token issued at Bilston in 1811 shows blast-furnaces at Priest Field. Another (Fig. 9), issued at Taunton, probably in the same year, shows a typical iron-foundry scene of the day.

The magnates of the new industries figured on many of the tokens; for example, Daniel Eccleston of Lancaster

(a very fine token), and Charles Roe of Macclesfield. The reverse of one of the tokens depicting Roe shows a variety of mining equipment. Other famous figures of the day figure on some of the tokens. John Howard, philanthropist and Fellow of the Royal Society, is seen on a Chichester and Portsmouth halfpenny of 1794 (Fig. 2).

The uses of the products of the newly expanded metal industries find their place too. Outstanding is a well-known token (Fig. 1) depicting the first iron bridge in the world—that erected over the Severn at Coalbrook Dale in 1779. It had, as the token states, a span of 100 feet. This bridge still stands, but its use is restricted to foot passengers. The reverse of the same token shows a water-wheel used to haul laden barges up an inclined place at Ketley. Metal sheathing for ships' bottoms was firmly established, but corrosion—mainly from the then not understood electrolytic effects resulting from two different metals coming in contact in a salt solution—was liable to cause serious damage. Hence the token of the Patent Sheathing Nail Manufactory at Bristol.

The chemical arts were developing rapidly at this period—which coincided with the Chemical Revolution in France—and they too are represented. A typical still of the day—typical also of much earlier days—is depicted on a beautiful token struck in 1797 for David Peters of Perth (Fig. 4). Joseph Priestly, the chemist, figures on a Birmingham token; on the reverse is shown an interesting collection of chemical apparatus.

Transport, too, was undergoing a revolution. The canal system was growing rapidly, and many tokens were struck to pay the "navigators" who built them and for other purposes. An example is a Thames and Severn Canal token of 1815, showing on one side a stylised canal-boat and on the other the entrance to a tunnel on the canal. A token by James Cuts of Oldham (Fig. 6) represents the growing railway system: it is undated, but considerably later than most of those we have considered, for it shows a Stephenson engine that did not appear until 1837. Air transport was initiated by Jean-François Pilâtre de Rozier in 1783. A balloon ascent made from Oxford in 1823 is represented on a token issued by Sparrow, a Bishopsgate ironmonger (Fig. 3).

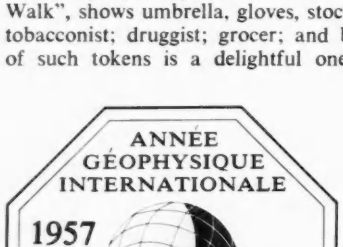
The great expansion and mechanisation of the textile industry was, of course, a principal feature of the Industrial Revolution, but the hand-loom weavers continued in existence, though often in deplorable conditions, for many years. Looms are depicted on many tokens; for example, on Jackson and Listers' penny token (Fig. 11). A Plymouth halfpenny of 1796 also shows a hand-loom and, on the reverse, a spinning-wheel. The latter was naturally a very common device at this time. Hand lace-making was still an important craft: thus a token issued in 1795 by Moore of 116 Great Portland Street—dealer in "muslins, Irish cloth, hose, etc."—shows traditional lace-making on a cushion.

At this time the petroleum industry was not established and, though some mineral oils were in use, whale-oil was an important commodity. The whale was then hunted from open boats with hand-harpoons, as depicted on a token, a collector's piece, of 1794 (Fig. 5).

Some examples of 18th- and 19th-century copper tokens (natural size).

Many other trades and industries, too numerous to detail, are represented on these interesting pieces. The industries include, for example, glass-making on some Bristol tokens, and printing on a Middlesex token. The trades include that of outfitter—a Norwich token of 1794, appropriately issued from "No. 2 Gentleman's Walk", shows umbrella, gloves, stocking, muff, and fur; tobacconist; druggist; grocer; and baker. An example of such tokens is a delightful one, showing a laden camel, issued by Lambe and Son, tea-dealers and grocers, Bath, in 1794.

One may appropriately end this account with mention of a token which depicts the kind of press in which they were made. This was hand-operated, and the considerable pressure needed was achieved by means of a screw fitted with a long handle. One such token was issued by William Lutwyche of Birmingham, one of the principal manufacturers.



THE INTERNATIONAL GEOPHYSICAL YEAR

MONTH BY MONTH

Compiled by Angela Croome

On October 4 the most important event of the IGY so far occurred when the U.S.S.R. successfully launched a 184-lb. Earth satellite into a nearly circular orbit over 500 miles high. Described as a test vehicle, it looped diagonally from the Arctic Circle to the Antarctic Circle at an angle of 65° to the Equator.

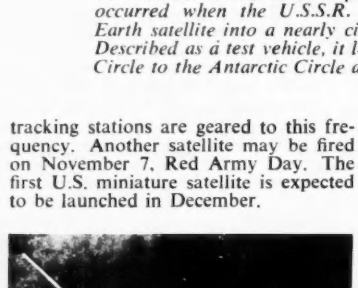
Sputnik

The outstanding features of the first Russian satellite called "Sputnik", the "travelling companion", are these: it weighed 184 lb., nearly ten orders of magnitude heavier than the scheduled American vehicle. It was fired into orbit at 600 miles high (Vanguard schedule, 300 miles); the accuracy of firing was such that the chosen angle of 65° to the Equator was only half a degree out. It is known that a three-stage rocket was used but not what fuel was employed. The third stage as well as the protective nose-cone went into orbit as well as the satellite.

The Orbit was an ellipse varying between 250 and 560 miles above the Earth. At first the perigee lay in the northern hemisphere and apogee in the south but precession would alter this eventually. At launching the orbital period was ninety-six minutes; after it had been up a week Soviet scientists estimated there had only been an increase of three seconds a day, representing an insignificant shortening in the orbit. The orbiting rocket, however, appeared to have fallen sufficiently to take up a nearly circular orbit 125 miles above the Earth by October 13. After starting 600 miles behind the satellite it had by then accelerated to a point 700 miles ahead.

Observations: By October 11, orbit computations had been made by the British, Americans, and Australians, beside the Russians. Important data on upper air temperatures had been obtained, said the Russians.

It is hoped that the Soviet Union will use 108 Mc/s as was promised last year for future satellites as IGY satellite-tracking stations are geared to this frequency. Another satellite may be fired on November 7, Red Army Day. The first U.S. miniature satellite is expected to be launched in December.



This is the first official picture of the Russian satellite, shown before it was inserted into the rocket for dispatch into the atmosphere for its circuits of the orbit. Note the folded aerials. This picture was radioed to Copenhagen and then wired to London.

Antarctic Perspective

New Zealand: The Government has earmarked £86.000 for New Zealand's contribution to the IGY of which a large proportion is to finance their two scientific stations in the Antarctic. In addition, the New Zealand contribution to the Trans-Antarctic Expedition will total £400.000, it was recently estimated. Of this considerable sum, by far the largest contribution from outside the United Kingdom, the New Zealand Government is providing £243.000; the public appeal has raised £29.864 and is still open.

Scott station was praised as one of the most efficient and comfortable polar camps by several distinguished visitors from other expeditions, during calls made to McMurdo Sound last season. Apart from construction and installation work a big programme of sledging, reconnaissance, and stores-laying was completed. Dr Fuchs has asked the New Zealanders to come very much farther south to meet the British party crossing from the Weddell Sea side. This throws a heavier burden on the Ross Sea section of the expedition under Sir Edmund Hillary. By the end of last season two large depots had been laid to aid in supplying the New Zealand support party journeying to meet Dr Fuchs near the South Pole and to cache supplies for both parties as they return. One depot of 14,000 lb. of stores was laid at Plateau Depot at the head of the Skelton Glacier at an altitude of 7500 feet. At the foot of the glacier another large depot was made; this is 250 miles from base by sledge route and 130 by air. It is planned that the transcontinental party shall descend from the plateau to the Barrier down the Skelton Glacier.

Early this season, Sir Edmund Hillary

conducted a reconnaissance twelve miles up the Ferrar Glacier to see if a tractor route existed. He reported back by radio, however, that the broken surface made the glacier impracticable for motor transport. After this his party moved on to Geniss Point to lay a depot for a surveying team that will leave Scott station in October.

During July the two sections of the Trans-Antarctic Expedition were in direct radio contact for the first time. Dr Fuchs and Sir Edmund were able to confer across the 2000 miles that separate them.

The installation of the scientific apparatus at Scott proceeded rather ahead of schedule during the autumn, and Dr Trevor Hatherton, chief scientist at Scott, was able to report that all was ready, in plenty of time for the opening of the Year. The trial period of observations in June proved of special interest; it coincided with a curious ionospheric phenomenon peculiar to polar regions and which is little understood. This appeared clearly on the sample records relayed to New Zealand from Scott. In April an earthquake in the Aleutians was registered on the station's seismograph.

Adare joint U.S. N.Z. station was established last New Year's Eve after the American ships carrying the base-establishing party had received a hefty battering by a sudden gale at the entrance to the bay where the station was located. The station is misleadingly named; it has been set up on the shores of Moubray Bay behind, and north of Cape Hallett, and some seventy miles from Cape Adare. Construction of the camp was complete by January 31. The construction party had a sharp struggle for possession of the camp area with 8000 Adélie penguins, part of whose nesting ground it proved to be. An over-wintering party of fourteen was left at the station under an American leader, Dr James Shear. Three New Zealand scientists constituted his scientific staff.

This season an extensive survey of the Ross Dependency (over which New Zealand holds territorial rights) will be undertaken from Adare station by an eight-man team that is to go there specially for the job. The survey will take in a large sector of the mountainous northern part of South Victoria Land where traces of a number of minerals including coal and copper have been found. The expedition will be split into two parties of four men each and they will man-haul all their equipment on Nansen sledges. Most of the survey area which is about the size of New Zealand is completely unknown. They will strike into the interior from Cape Hallet from which a sheer 3000-foot-high bluff rises; it is hoped that by sledging over bay ice a way round this obstacle may be found. The leader of the surveying team is Dr H. J. Harrington, who led an Oxford University expedition to the Himalayas in recent years.

Starting an Ice Museum

If all the diaries and contemporary chronicles of the world were destroyed tomorrow it would still be possible to sort out the dry summers from the wet back to the time of Christ—from the glaciological record. This is the implication of some striking conclusions given by Dr Henri Bader, Chief Scientist of the U.S. Army Snow, Ice, and Permafrost Establishment, in a paper delivered at the Washington symposium on IGY studies held at the National Academy of Sciences just before the Year opened.

What may prove of far greater interest is that volcanic ash, meteorites, spores, and bacteria that fall with the snow are maintained in perfect condition in the annular layers of the ice of the two great ice-caps of the globe, Greenland and Antarctica. For instance, ash from the 1912 eruption of the Katmai volcano in Alaska was easily identified 32 metres down in the northern Greenland ice-cap. Traces of the huge Krakatoa volcanic explosion of 1883 when the top of the mountain blew off, are expected to be discernible in the ice-caps of both hemispheres—at about 50 metres in Greenland and 20 down in Antarctica.

The 2000-year *terminus ad quem* of this newly discovered method of studying nature's past is due not to the limit of ice-depth but to the limitations of present techniques in obtaining ice-cores. The longest core so far brought out intact has been 300 metres. This was done first last year by members of the U.S. Snow, Ice, and Permafrost Establishment working on the Greenland ice-cap in the vicinity of Thule. Here deposition is heavy so that on average 1 metre in depth corresponds to two years of snowfall. At the bottom of the 300-metre SIPRE cores, therefore, the snow was 600 years old. Elsewhere in Greenland and in Antarctica annual snowfall is lighter so that each metre of ice-core contains about seven years' precipitation of snow. As it is known that these great ice-caps extend down at least 10,000 feet there are, at a conservative estimate, 20,000 years of natural history locked away in the ice.

Since all the ways in which dated ice-cores can be made to yield valuable information have not yet been explored, SIPRE is starting an ice-core museum. All the cores recovered are sliced in half lengthwise and one half of each is preserved, frozen, for future reference. This will particularly help scientists engaged in assessing the increase in radiation background due to nuclear explosions. Radioactive substances in the atmosphere are trapped in the falling snow and can be detected until the end of their half-life; in the case of tritium, the isotope studied in this connexion, it is twelve and a half years. The ice provides the only means now of going back to the pre-atomic age for comparisons with present-day levels of background radiation.

By studying the extent of atmospheric pollution in recent years against evidence in the snow of the pre-industrial era, a measure of the way the air we breathe has been affected by industrialisation can be made.

Nuclear Geophysics

The first nuclear explosion of which geophysicists had advance notice proved rather disappointing. This was the atom-bomb in the kiloton range detonated underground in Nevada on September 19. Although some 600 seismic stations round the world were alerted, preliminary reports suggest that the tremor was not observed beyond a radius of 1000 miles from the seat of the explosion. Japanese meteorologists were the only scientists overseas who thought they might have picked up a record of the explosions. The Australians, whose seismographic stations at Sydney, Melbourne, and Brisbane were all set to pick up the waves, observed nothing. Prof. Keith Bullen, F.R.S., of Sydney University has long maintained that seismologists should be given advance notice of the time of detonation of nuclear bombs because of their potential value for Earth studies. At the IUGG meeting at Toronto, Prof. Bullen described successes he had had in observing some of the H-bomb tests in the Pacific on seismic instruments located in Australia. This was a piece of private enterprise. He received no official notice and had to make a guess at the exact time when each bomb was detonated.

Off-shore in New Zealand heavy underwater explosions were produced at the end of the summer so that geophysicists from the Department of Scientific and Industrial Research and from the Naval Research Laboratory might study the Earth's crust in the Auckland area. The detonations were carried out off the coast near Leigh, a small settlement fifty-eight miles north of Auckland. A series of listening-posts stretching from Cambridge (N.Z.) to Waikato observed the explosions. These tests were complementary to a previous series that gave data on the Earth's crust in the Wellington area.

Recent Solar Activity

At any maximum of the solar cycle, periods of fairly frequent disturbances of magnetic and ionospheric phenomena can be expected.

The International Geophysical Year has been timed to coincide with such a period of activity so that the effects on the Earth can be assessed.

The disturbances at the beginning of July and September were caused by several medium-sized sunspot groups and associated large flares.

The Royal Greenwich Observatory states that, although the Sun was very active at these times, its behaviour was

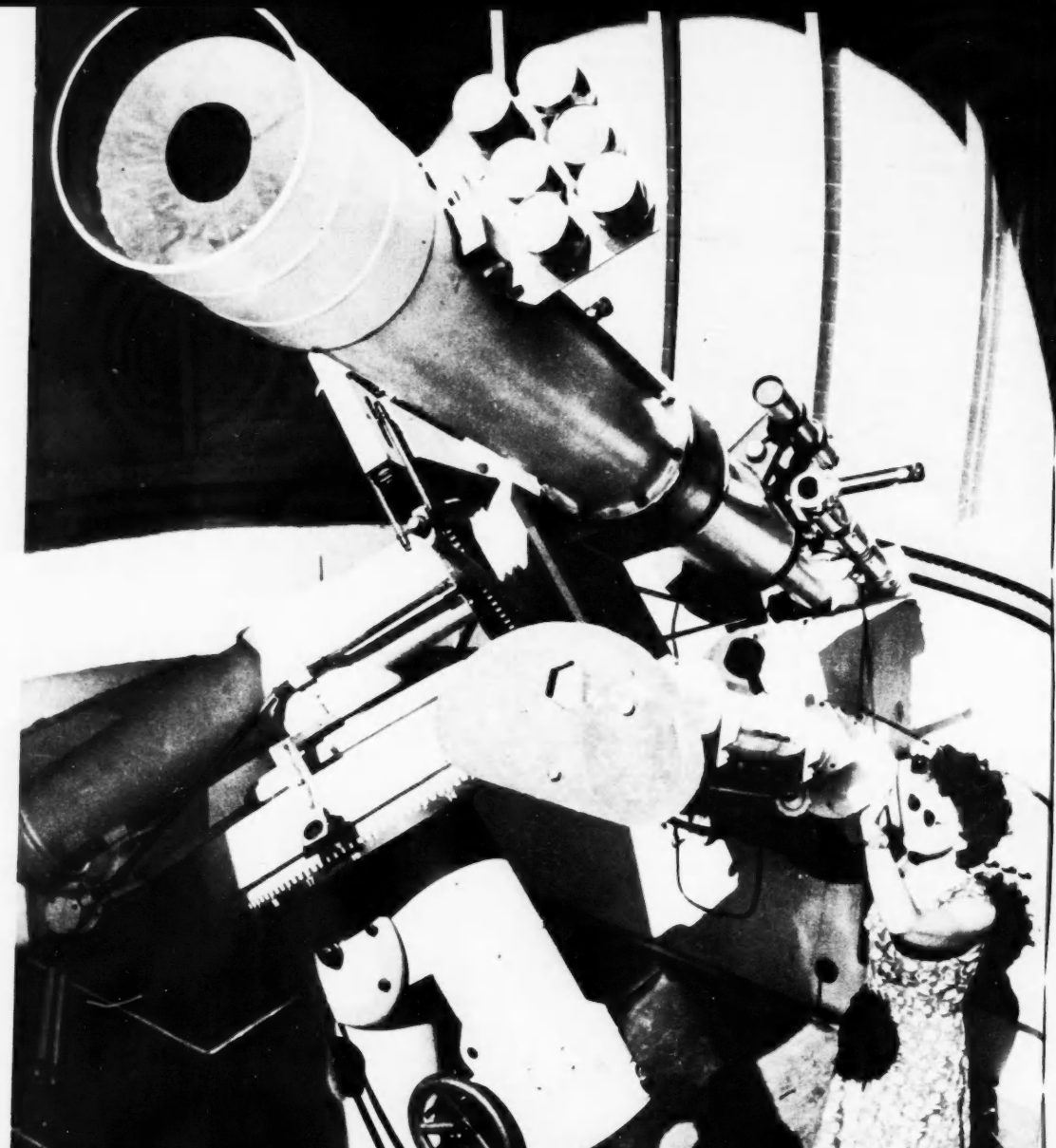


FIG. 2. The Astronomical Institute at Ondrejov, near Prague, is one of the stations taking part in the IGY. Chromospheric eruptions of solar activity have been observed there by means of a spectro-helioscope since 1948. During these nine years more than 1300 eruptions have been observed. In addition to visual observations, photographs are also being taken. In this photograph Blazena Ruzickova is shown photographing the photosphere.

consistent with what can be expected at such a period, and it should be borne in mind that the present cycle has so far produced no sunspot group reaching even half the size of the giant group which crossed the Sun's disk in April 1947. This group, although the largest recorded since the Daily Greenwich records began in 1874, amounted to no more than 0·007 of the Sun's visible hemisphere.

In spite of exaggerated reports since the beginning of the International Geophysical Year, no flare has been observed exceeding that of July 1946, in size. The most outstanding event of the present solar cycle was the flare of February 23, 1956, which caused an unprecedented increase in cosmic radiation.

As the Sun is at or only just past, its maximum activity, the recurrence of disturbance similar to those recently experienced cannot be regarded as exceptional.

Losing a Continent

It looks as if the Earth may contain one continent less than we had thought. Findings during the past year by both Soviet and American glaciologists suggest that the vast Antarctic ice-cap with an area of at least 5 million square miles sheathes no continental land-mass, as has been supposed since the early days of the last century. The ice may be resting on the ocean bottom and may be pierced here and there by the spikes of mountainous islands.

Here is a change of view almost as radical as that brought about by Capt. Cook's southern voyages in the 1770's. For several centuries before Cook sailed south, European travellers had nourished an attractive myth of an extensive and balmy land of plenty, situated somewhere in the vast Antarctic. Probing the south-polar ice-pack for much of its perimeter, Cook found nothing but swirling mist, forbidding "ice-islands", and intense cold; of an earthly paradise there was no sign, and Cook wrote a scathing report discrediting the legend. He implied that only a fool would sail farther south than he had ventured, and declared that no profit could be derived from such a forbidding land, if land there proved to be.

At last we begin to approach the day when it will be known for certain whether Antarctica is a land mass or not; and the latest pointers suggest that it is not. Last January the Americans completed a glaciological traverse of nearly 650 miles between Little America and their ice-plateau station of Marie Byrd. It showed the ice-cover to be 1950 feet thick at the Little America end of the profile and a little short of 10,000 feet thick at Marie Byrd. But Marie Byrd station stands only 4950 feet above sea-level so that the ice must therefore rest directly on the sea-bottom—as far below the sea's surface as the ice-plateau stands above it.

FIG. 3. An exhibition was held recently in London of the clothing, equipment, and food to be taken by the Medical Research Council Expedition to the Antarctic in December. The expedition is to join Sir Edmund Hillary's party on Dailey Island, in the McMurdo Sound. This photograph shows the IMP, a mask to be used for the measurement of energy expenditure.

Working in two separate sectors of Antarctica, the Indian and Atlantic Oceans, Russian glaciologists have had similar startling results. Two hundred and fifty miles into the interior from Mirny, measurements have shown that everywhere in the region the bottom of the ice-cover lies well below sea-level. Data from the Pacific sector shows the same. "All this impels us to revise our former ideas about Antarctica," commented Prof. G. A. Avsyuk, head of the glaciological programme of the Soviet IGY committee, in a recent interview with Tass. The conclusion to be drawn, he says, is that Antarctica is not a continent but possibly an archipelago of large islands: "In searching for an explanation . . . we can put forward the hypothesis that the Antarctic continent which once existed sank into the depths of the Earth under the colossal pressure of the ice." Before absolute certainty can be reached about the nature of Antarctica, numerous other ice-soundings will be needed. The ice-profile to be made by the British Trans-Antarctic Expedition during its crossing should, however, prove conclusive.

If no continuous continental land-mass is found, there will have to be a re-estimate of the volume of Antarctic ice. Prof. Avsyuk estimates that the previous computation of 20 million cubic kilometres as the volume of Antarctic ice will prove to be between 33% and 50% short of the mark.

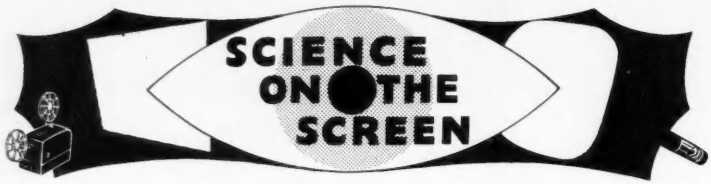
Some interesting possibilities are raised by these new figures should the world's ice-cover be in permanent retreat, as some suppose. The flood resulting from the total melting of the world's ice would be twice as high as previously thought. But such changes are only to be foreseen in terms of geological, not historical times.

Vostok Supplied by Air?

Professor Bardin, chairman of the Soviet IGY Committee revealed recently that the eight-man party that was halted by the impossible conditions half-way to the position of Vostok, the geomagnetic pole station, will proceed at the first opportunity this spring. On arrival in the area they are to prepare a landing-strip. The party, which is using motor transport, had to give up the plan to establish Vostok in time for the opening of the Year. They wintered at an intermediate position which has been called Vostok I.

Last season the Russian's intentions were to establish both Vostok and Sovietskaya, the pole of inaccessibility station, by tractor-train. If necessary these were to continue travelling deep into the Antarctic winter. Such a venture has not been attempted since "the worst journey in the world", when three members of Scott's 1910–12 expedition travelled to the Emperor Penguin rookery at Cape Crozier. It was a bold move indeed on the Russians' part to take mechanical vehicles on a long journey across unexplored terrain in the darkness and cold of the polar night.

It now appears that the original plan is being modified and that the main supplies for Vostok, at least, are being ferried in by air.



Television in Education

After last year's experiments, television broadcasting to schools, in the two TV programmes, has now begun in earnest, and Science is occupying a prominent place. It is now time to take stock of the project before it becomes heavily involved in vested interests. Indeed already in Panorama (BBC September 23) the matter has been tentatively raised in recorded interviews with teachers and pupils.

Whether desirable or not, school television broadcasts are intimately related to the whole question of using films for teaching, if only because TV school broadcasts have been using a good deal of film. There is a difference between the professional, cut, trimmed, dubbed, and edited film of the type seen at the cinema and in school, and a film-recording of a TV broadcast; for the latter is virtually the same as a "live" broadcast and must be considered as such.

First then, what does teaching with the edited sophisticated film offer? One can see three attractions, namely: (1) accessibility, (2) concentration, (3) technical clarification. As to accessibility, pupils can travel round the world while still sitting at their desks. As to concentration, one need only compare the content of a well-planned film to the meagre content of any half-hour verbal lesson. As to technical possibilities, the slow-motion camera, the stopping of moving parts, the arresting of birds in flight, the night photographs of owls, the thousand-and-one other tricks, all have immense educational value.

What, then, are the dangers and drawbacks, if any? In a film the whole teaching scheme is mechanically, rigidly imposed, irrespective of local interests. The very concentration automatically imposes superficiality, except in those narrow films specifically devoted to one small theme (and such films are by far the best). The inevitable absence of a "live" teacher is a weakness. Of course there is usually a follow-up lesson by the teacher, often with excellent notes. But the keen anxious demand for an answer *at the critical moment* is lost, and the questions *after* the showing lose much force and content. Most dangerous as a result of this is the possible induction of a lazy, slothful satiation, without real stimulus to think; in other words there is a danger of being entertained rather than being taught. Yet most teachers welcome film and presumably they hope that careful teaching afterwards will minimise the faults of the medium.

How then does TV compare with this? Merely to use edited film is to fail entirely to exploit the medium. Unfortunately far too much professional film is being used in TV schools' broadcasts. TV must definitely *not* be just one more film session, and by judicious exploitation of its potentialities it certainly need not be so. A prime distinguishing feature from the edited film is *topicality*. TV can be "red-hot", always, whereas even the best film from the film library is always just that little bit stale; many are sadly dated. A topical programme, whether on the farm or on the weather, in the selection of geographical sites of current interest or the description of new discoveries, must use the "live" broadcaster, with film as a subsidiary background only. Real teaching techniques are possible, with questioning and recapitulations. Such techniques have already been admirably used in some of the experimental ITA schools' broadcasts dealing with the IGY. It is to be hoped that there will be considerable extension of this approach. It may be well worth the experiment of taking TV cameras straight into the school-room, right behind the class, with a camera shot giving the viewer the impression he is in the class itself. The broadcasting of an expertly prepared lesson would pay dividends. There are expert teachers who could hold sufficient interest, provided as much care is put into the preparation of such a live broadcast as goes into the production of a studio broadcast (incidentally, much more than the average viewer even dreams of). In such a broadcast one might hope to capture that indefinable freshness given by the teacher. If a keen hand instinctively shoots up when the teacher on the screen asks a poser, this will be just what we want.

Of course film shots and sequences can be used to advantage, but only as accessories. The first of the new schools' broadcasts (The Farming Year, ITA September 23) consisted entirely of film with a running commentary. All film sequences were excellent in themselves, but this was certainly no adequate exploitation of the possibilities of TV.

S. TOLANSKY

A Film of the Andes

Every expedition nowadays likes to make a film record of its journey and progress. The Cambridge Expedition to the Colombian *Cordillera Oriental*, part of the northern Andes in South America, will include some mountaineering sequences in their film.

Using a Bell and Howell, Model 70, 16 millimetre ciné camera, the five men (all under twenty-five) who comprise the expedition aim to climb and survey the High Andean Zone of the Sierra Nevada del Cocuy, make a selected botanical collection, and produce a photographic record of the area. The film will show the progress of the expedition and any interesting local features such as native ceremonies, customs, and work.

Scientific Films at the B.A. in Dublin

"Reproductive Behaviour of Sticklebacks" reminds us that good subject-matter can be left to speak for itself. The film (a silent one) was unsophisticated, almost crude, in technique, yet of compelling interest.

The "puff" treatment which sponsors usually prefer was conspicuous in "Grinding a Telescope Mirror" and "The Kitimat Story". "High-Speed Flight", by contrast, was the perfect sponsored film, the Shell symbol at the end being the only sign of its origin. This outstanding film used animated diagram, shots of wing behaviour in wind-tunnel studies on the development of stress, and views of planes in flight, to explain with crystal clarity, Mach numbers and the significance of Mcrit.

Other interesting expository films were "The Embryology of the Eye", difficult for the layman to follow, but technically a beautiful presentation; "Atomic Achievement", which explained the working of a nuclear reactor; and "Motion Study Principles", tediously paced, yet fascinating in its illustration of the tremendous savings in time and energy that may be effected in even a very simple manual operation: the assembly of a nut, bolt, and two washers.

"Mutton Birds of Bass Strait" and "The Culbin Story" were among the documentary type films of particular interest. "The Culbin Story" chronicled the amazing project of "thatching" 40,000 acres (and still 20,000 to go) of sand-dune country on the Moray Firth to stabilise the sand and allow the successful growth of a forest of Corsican pine. The simplicity and vastness of the scheme made it exhilarating to watch.

The Russian film, "A Recent Crater-Forming Meteorite", was an example of subject-matter nearly obliterated by the ministrations of a dull and old-fashioned photographer and producer.

J. A. SIMONS

Merseyside—S.F.A.

The Merseyside Industrial and Scientific Association set up in May of this year, opened its 1957–58 season on September 26 with a programme of film. The Association is an autonomous body having close links with the Scientific Film Association. A programme of meetings covering various aspects of the scientific film has been arranged, together with a series of viewing sessions to enable members to preview films in their own particular field. The S.F.A. Journal, *Science and Film*, will be distributed to all members of the new Association who may call on the S.F.A. film information service.

R. RATHBONE

LETTER TO THE EDITOR

The Age of the Earth and the Universe

Sir:

In DISCOVERY, May, 1957, p. 213, a summary of my report* gave the age of the Earth as 3500 million years (the universe being perhaps 1000 million years older). You pointed out to me that there is a discrepancy between the figure for the age of the Earth as given in my report, and a recent figure of 4500 million years derived by Prof. A. Holmes,† which is practically equal to the age of the meteorites (4550 ± 70 million years).

The discrepancy is partly only apparent, as some of the indirect evidence for the greater age used by Prof. Holmes, namely that of meteorites, has been considered also in my report* but has been given a different interpretation. The direct estimates of the age of the Earth's crust, based on the isotopic composition of lead ores and available at the time when I revised my report (July 1955), were 3350 ± 300 million years by Holmes (1946) and 3500 million years by Collins, Russell and Farquhar (1953). The new direct determination by Holmes,† leading to an age of 4500 ± 100 million years, was published after my report. The discrepancy is thus between the old and new determinations, pointing to the uncertainty of the method based on extrapolation and selection of the material. Although the new value may be better, it is by no means as accurate as indicated by the calculated probable error; the smallness of the error is due partly to subjective elimination of discrepant values. The old determination differs from the new one by 1150 million years, almost four times the theoretical uncertainty which was estimated to be only ± 300 million years. The true uncertainty of the new value may be greater in the same proportion and amount to some 400 million years; there is no way of guessing in which direction an accidental error may lie, but, if the old determinations carry any weight as a piece of impartial evidence, it is still probable that the Earth's crust is by a few hundred million years younger than the material of which the meteorites are made. This is also borne out by statistically rigorous treatment by Russell and Allan,‡ who "with mathematical impartiality" (qualification by Holmes†) did not indulge in rejecting discordant cases and arrived at a figure of 4300 ± 400 million years for the age of the Earth.

The ingenious lead-ore method of age determination, developed by Holmes, considers the radioactive production of lead isotopes from the isotopes of uranium and thorium. The different isotopes are produced at different rates, and their ratio varies with time. A lead-ore mineral like galena, once formed, contains practically no uranium or thorium, and its isotopic composition remains unchanged as it was at the time of formation. By comparing lead ores of equal age but different isotopic composition (due to different prehistory), and for different age groups, the time when the isotopic composition was the same for all samples can be found. This time corresponds to the end of complete mixing of the rock materials, or probably to the end of the molten condition, that is, the time of solidification of the crust.

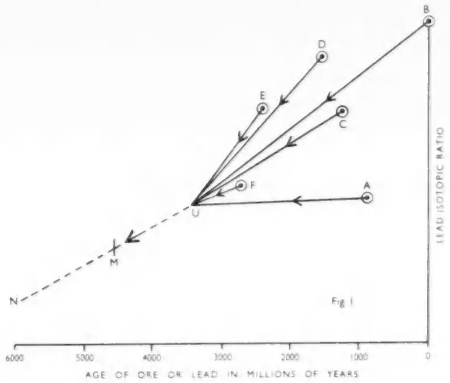


Fig 1

The method of Holmes is rather complicated. Its equivalent, however, can be simply explained by analogy as follows. Let, in the diagram, the abscissae be ages, in millions of years before the present, and the ordinates be certain lead isotope ratios. Points *A*, *B*, *C*, *D*, *E*, *F*, show isotope ratios of lead ores, each at the time of ore formation. Previous to that time the lead of the ores was distributed in a rock matrix, and its isotopic ratio was varying, that is, increasing with time at different rates depending on the concentration of radioactive elements as shown by the lines *UA*, *UB*, etc. Going backwards in time, as indicated by the arrows, the isotopic ratios converge and become identical in the point of intersection, *U*; this is shown in the figure to take place 3500 million years ago, and is the time of solidification, or the formation of the crust.

However, previous to this, radioactive processes may have been going on for an indefinite period, with the isotopic ratio varying as shown by the broken line *UN*. At point *M* the isotopic ratio becomes equal to that of iron meteorites (in which the ratio remained constant since their formation, on account of the absence of radioactive elements); according to Patterson,§ the age of *M* is 4550 ± 70 million years, the small probable error being more or less real because the figure is based on averages. On the other hand, the age of *U* as based on the intersection of lines of only approximately known slopes is rather uncertain (the exact intersection in the diagram is but an idealisation), whence the discrepancy between the various determinations. The newest determination by Holmes would put *U* close to *M*.

If the two points do not coincide, and, as is likely, the point of solidification, *U*, follows *M* in time, the stretch *MU* shows the variation of isotopic composition of the Earth materials preceding solidification. This, however, does not necessarily mean that the Earth itself existed all that time; its materials may have been then in space in dispersed form, as meteorites, dust, or even gas.

The materials, if not the globe itself of the Earth, must have existed at least as early as *M*, the time of differentiation of iron in meteorites. Whether there has been a considerable prehistory to *M* is unknown; however, there is a limit to it, about 5500 million years ago, which is the maximum age of the lead isotopes and the chemical elements in general, as follows from the decay rates and present abundances of the radioactive elements.

The evidence for the different ages is as follows: 1, the crust, and probably the globe of the Earth, is from 4000 to 4500 million years old; 2, the formation of the small planets which, in breaking up, later created the meteorites, took place 4550 ± 70 million years ago; this is also the probable age of the solar system; 3, the elements, and the universe itself, cannot be older than 5500 million years; their probable age is close to, or but slightly greater than 4500 million years.

E. J. ÖPIK

Armagh Observatory,
Northern Ireland

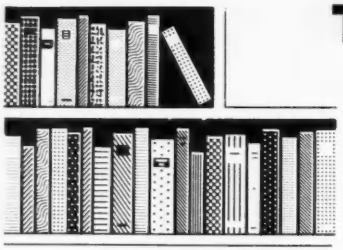
* "The Time Scale of Our Universe", E. J. Öpik, *Smithsonian Report, 1955*, pp. 203-26.

† "How Old is the Earth", Arthur Holmes, *Trans. Edin. Geol. Soc.*, vol. 16, part 3, 1956, pp. 313-33.

‡ "The Age of the Earth from Lead Isotope Abundances", R. D. Russell and D. W. Allan, *Geoph. Suppl. Mon. Not. Roy. Astr. Soc.*, vol. 7, 1955, pp. 80-101.

§ "Age of Meteorites and the Earth", Claire Patterson, *Geoch. et Cosmoch. Acta*, vol 10, 1956, pp. 230-7.

THE BOOKSHELF



The History of Photography: From the Earliest Use of the Camera Obscura in the 11th Century Up to 1914
By Helmut and Alison Gernsheim (*London, Oxford University Press, 1955, xxviii+396 pp., 70s.*)

The Festival of Britain year 1951 included an exhibition of Victorian Photography at the Victoria and Albert Museum which was in fact rather more than its title implied, for here was represented, in a magnificent collection of apparatus, books, and photographs, the history of photography. Since then, this superb collection has disappeared from the public gaze and presumably is now stowed away in inaccessible cupboards, trunks, and boxes, awaiting the time when a permanent museum of photography (and cinematography) can be established.

The exhibits shown in 1951 belong to Helmut and Alison Gernsheim and it is therefore not surprising that their "History of Photography" should prove to be the best and most accurate history yet written. If supplemented by their other writings on the subject, such as the monumental book on "Daguerre: The History of the Diorama and the Daguerreotype", London, Secker and Warburg, 1956, and by various monographs and articles in the photographic press, their documentation of the history of photography is amazingly comprehensive and it may be a very long time before it can be surpassed by any other historians.

There have been many histories of photography, but never one quite like this, for as well as taking into account the progress of invention, they have not neglected the photographers themselves. If there is an adverse criticism to be made, it is that, like most photographers, the Gernsheims over-play the aesthetics of the medium and we are made conscious of a determination to convince us that photography is indeed a fine art—and yet we are left unconvinced. Though the professional photographer may agree with this attitude of the authors, others, less biased, will maintain that photography is at its best as a medium for accurate recording, both as a research instrument and as the means for lively illustration in the hands of an imaginative and selective observer.

The book is divided into six parts: prehistory; invention, early years; collodion period; gelatine period; photography and the printed page. The chapters themselves deal with a wide range of topics which a reading of the part-headings alone cannot convey. For example in the first part, after tracing the history of the camera obscura and the various chemical investigations relative to photographic emulsions, we have a delightful chapter on "Phantoms of Photography". Here are forecasts of the medium to come, the earliest dating from 1760. However, omitted from the chapter, but perhaps too fanciful for inclusion, is the little-known tale of the wooden cup related by the Franciscan Friar Salimbene in his autobiography of the Middle Ages. The cup was being brought back from the Mongol capital of Karakorum by Brother John of Piano Carpini as a present to Pope Innocent and was shown to Salimbene who writes that "in the bottom of [it], as I saw with my own eyes, was the likeness of a beautiful queen, not carved or painted by an artist, but impressed on the wood by the influence of the stars". This is quoted by Maurice Collis in "Marco Polo and Kublai Khan" in *World Review*, N.S. 19, September 1950, p. 22.

The Gernsheims make no prophecies for the photography of the future, but rightly conclude their scholarly work (which is admirably illustrated) with a plea for the setting up of a national museum and institute of photography.

JOHN BARNES

The Black Cloud
By Fred Hoyle (*London, William Heinemann, 1957, 254 pp., 15s.*)

Fellows of the Royal Society have seldom ventured into purely literary fields and Mr Hoyle appears to be the first to have published a novel. "The Black Cloud" is, of course, a special novel—and is dedicated, primarily, to fellow astronomers. Certainly astronomers, both professional and amateur, will find much in it to tickle their palates (there are even some mathematical footnotes!) but the book has a much wider appeal and can confidently be recommended to everyone who likes a rattling good story, well and excitingly told. Mr Hoyle, in a preface, calls the book a "frolic" and clearly there is no suggestion that here is a great literary epic although in the course of the story we are plunged into a world of catastrophe and sudden death, a world which the literary giant could have pictured in such a way as to make our blood run cold. Nevertheless Mr Hoyle, who has never been wanting in imagination, has here written a full-length novel which sustains the reader's interest and excitement throughout and is, in brief, thoroughly good science fiction, never stretching too far the possibilities of what could be. Moreover the reader is treated to some intriguing exchanges, verbal and otherwise, between scientists and those whose joy it is to control the political scene, and some only-to-be-expected comments on prejudices and ideas of the day; one way or another there is seldom a dull moment.

The story? Neither wild horses nor untamed fission will drag from this reviewer more than to say that the theme concerns the approach towards the solar system of what appears to be a dark obscuring cloud of gas and the subsequent results. The implications may seem obvious but the reader is advised to remember the old mathematician's advice "when you want to extrapolate—don't!" The book has, not surprisingly, the recommendation of the Book Society and, with its excellent dust cover by Desmond Skirrow, should either be bought, borrowed or at least acquired somehow.

C. A. RONAN

Chemical Engineering Practice
Vol. 3, Solid Systems. Edited by Herbert W. Cremer and Trefor Davies (*Academic Press Inc., New York, $13.30; Butterworths Scientific Publications, London, 95s.*)

This book, the third in what is intended to be a comprehensive text on chemical engineering, is concerned with the physical processing and handling of solid materials. In it are described some of the most important operations in the process industries—crushing, grinding, classifying, mixing, storage and handling, and finally the rather special but topical problem of the removal of dust particles and mists from gases. When in the evolution of industrial technology it was recognised that it was logical to classify processes common to many industries as "unit operations", the chemical engineers considered the crushing and grinding of solids as one of these "unit operations". Associated with these processes inevitably was the screening and grading of small particles and so on. Now that chemical engineering is generally accepted in the universities as a scholarly subject, there has been a tendency of recent years to miss out of the teaching courses any topics or operations which were considered to be essentially descriptive, and crushing and grinding came under this heading. University courses usually contain useful lectures on the mathematics of particle size analysis, or the fluid mechanics of the settling of small particles, but the mechanics of crushers or grinders are apt to be missed out. The teachers will certainly welcome this book, which they can commend to the students as containing all they are likely to require on the subject.

The subject-matter is essentially practical. The text is profusely illustrated and the drawings are clear. It is in the

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main written by people employed by famous makers of industrial equipment which finds application in this field. There is an exception; Dr Heywood, who has written the sections on the principles of crushing and grinding, on the methods of size analysis, and on the mechanics of pulverisers, is a Reader in Mechanical Engineering at Imperial College. He is known for his contributions to the art of mineral dressing. While this "unit operation" perhaps finds its most important applications in the mining and metallurgical industries, the examples described are by no means confined to these industries. The milling of grain, or more particularly the principles of operation of the machinery used, is described at some length. Naturally the processes associated with the cleaning of coal, including recent work using flotation methods, are discussed. There is useful information on the storage and handling of solids and this section includes a good discussion on the types of conveyer and their principles of operation. The chapter on electro-precipitation presents useful data on the generation of dust in a number of industrial processes, and on the performance of electro-precipitators in operation.

In the preface to the first volume of this series, the editors stated that it was thought appropriate to include what some may regard as a disproportionate amount of *theory* in a treatise in the title of which they are likely to regard *practice* as the objective word. In the present volume, the third, there is no doubt that *practice* is the objective word. When the theory is sufficiently well understood and can usefully add to the presentation, it is given. Even when it is speculative, as in the employment of Danckwerts' suggestions for the characterisations of mixtures, it is mentioned. But on the whole this book concerns itself with describing processes and equipment, and this it does very well.

E. S. SELLERS

Seismology. Historical Survey and Catalogue, Science Museum

(*London, H.M. Stationery Office, 1957, 3s. 6d.*)

The first half of this pamphlet gives a simple account of what is known about earthquakes. It starts by reviewing the various theories that have been held as to the origin of earthquakes; it then describes the development of the seismograph, the records that it gives and the knowledge that has been obtained from them about the interior of the earth. The last chapter describes the methods of seismic prospecting.

The second half of the pamphlet gives a catalogue of the seismological collection of the Science Museum. The Museum possesses a remarkable collection of early seismographs constructed from 1880 to 1914, but is naturally less well provided with modern instruments.

E. C. BULLARD

Yulengor, Nomads of Arnhem Land

By Wilbur Chaseling (*London, Epworth Press, 173 pp., 21s.*)

Wilbur Chaseling's *Yulengor, Nomads of Arnhem Land*, is one of the most appreciative and sympathetic books that has been written about the aborigines of Australia for many years. It is also a fascinating story of how a lone man and woman made their home among a tribe of aborigines in a remote corner of Arnhem Land, aborigines who, in the previous two years had killed a number of both Europeans and Asiatics.

Yet, in spite of their previous bad record, these people turned out to be a thoroughly delightful, kindly and co-operative folk. This change toward the white man was, without doubt, due to Chaseling's sympathetic approach, for, in his book, the author states that he was determined not to use force, nor attempt the dual role of policeman-missionary, with a gun in one hand and the Bible in the other. Instead of this approach, adopted by far too many missionaries, he learned their language and through that medium set out to understand their laws and their means of gaining a livelihood. It was only when he reached that understanding, and not before, that he suggested alterations to the culture of these nomads so that they would be better equipped to meet the problems associated with their inevitable contact with the more advanced civilisations.

The book deals mostly with the aborigines, their philosophies, and their way of life; the author makes little reference to the many frustrations, disappointments, hardships and often real danger which he must have experienced in that remote and untamed land.

Apart from "Yulengor", being a readable account of the aborigines and their many delightful qualities (which, in a secondary way, reveals the personality of the author), it has a considerable value as a scientific document. It so happens that I have just completed a book that deals, in part, with the myths and beliefs of the same aborigines as the author describes, and am therefore in a position to know how accurate are many of the ethnological facts recorded by Wilbur Chaseling. Although, in common with others who have worked in the same area, much of his data is incomplete, nevertheless, the information that he has gathered fills many gaps in our knowledge of the myths and philosophies of the aborigines of western Arnhem Land.

In a simple, easy style, the author deals with all the major aspects of aboriginal life in Arnhem Land, the family relationships, the arts and crafts, the medicine-man, the avenging ceremonies and blood feuds, the creation of the world and the future life. It is a book to be highly recommended to all who are interested in primitive people and their contact with the outer world.

CHARLES P. MOUNTFORD

The Great Chain of Life

By Joseph Wood Krutch (*London, Eyre and Spottiswoode, 1957, 227 pp., 21s.*)

A book written by a self-confessed "nature lover" with trans-Atlantic verve and buoyancy, "The Great Chain of Life" will certainly appeal more to the layman than to anyone who understands the scientific approach. The author argues dogmatically that sub-human animals are full of the joy of life that he himself evidently feels ("they share our emotions even though they cannot share our thoughts"): but he glosses over the obvious illogicalities of his subjective anthropomorphisms if, indeed, he is even aware of them. With delight he tilts at various windmills created by his fertile imagination and often credited by him to the various scientists to whom he is indebted for some of his information. Unfortunately he appears not to appreciate the biological significance of many of the facts that he misinterprets with such enthusiasm. And he misses completely the real problem of the relation between purposiveness and directiveness in ethology.

"Like us, robins have their problems but they seem better to take them in their stride. We are likely to awake with an 'Oh, dear!' on our lips; they with a 'What fun!' in their beaks" (p. 213). This type of remark is really inexcusable since the production of Konrad Lorenz's books has made the modern concepts of animal behaviour available and intelligible to everyone. And what is to be made of the claim that a fern is different from a frost flower because "the fern 'wants' to be left alone in its cranny by the rock" (p. 191)?

Bernard Shaw's vitalistic teleology, upon which Mr Krutch leans so heavily, has elsewhere been aptly described as a "caricature of Lamarckism". This book caricatures many of the most subjective and teleological of the horrors of *uncritical* "popular" writing. The nonsense which is presented with such disarming sincerity would easily mislead the young. They are much safer with Beatrix Potter who does not pretend that all rabbits think like the Flopsy Bunnies!

The book is well printed and the scraper-board illustrations by Paul Landacre are attractive in design although somewhat crudely executed and often inaccurate.

J. L. CLOUDSLEY-THOMPSON

Structure de la Médecine Chinoise

By P. Huard (*Paris, Conférences du Palais de la Découverte, 1957, Ser. D. No. 49, 88 pp., card covers, 590 fr.*)

Traditional Chinese medicine is now attracting a great deal of interest; in China much effort is being made to find out what it can contribute to modern medicine when experimentally tested and rationally interpreted; in the rest of the world the problem of the achievements of ancient and medieval Chinese

science and technology looms increasingly large in the frame of the history of science as a whole. For many years Prof. Huard was Dean of the Faculty of Medicine at Hanoi in Indo-China, and has more and more devoted himself to the history of medicine in China and south-east Asia, a subject on which many theses were written by his pupils. In the present brochure he has given a very concise and broadly accurate account of medical science as it developed spontaneously in the Chinese culture-area. While not sparing of criticism where it is due, he never misses an opportunity of doing justice to the achievements of Chinese physicians, such as the introduction of variolation (predecessor of vaccination) in the 12th century A.D., or the description of measles by Chih Fa-Tsun five hundred years before Rhazes, or the general use of mineral drugs a millennium before the Paracelsians in Europe conquered the Galenists. The little book is a mine of information.

JOSEPH NEEDHAM

Brief Notes

Because of the economic losses caused by infertility in cattle, the Food and Agriculture Organization of the United Nations convened a symposium in Copenhagen in December 1954. Papers from this and other meetings have been combined in a booklet, "*Vibrio Fetus* Infection of Cattle", obtainable from the Commonwealth Agricultural Bureaux, Central Sales Branch, Farnham Royal, Slough, Bucks., England.

The Centre d'Etude de l'Azote, Geneva, has published an interesting volume on "The Manuring of Sugar Cane", prepared by D. J. Halliday, of ICI. The first part of the book deals in general terms with sugar-cane production, the plant and its cultivation, fertilisers, and manures. The second is devoted to field experiments in the Americas, the Far East and India, to determine the best nitrogenous fertilisers to be used under local conditions. The publication is lavishly illustrated in colour and monochrome, and a twenty-two-page bibliography, arranged geographically, is given at the end. The book is not generally available but copies have been distributed to university libraries and agricultural research stations all over the world.

The Central Office of Information, which is responsible for the Central Film Library, has brought out (in addition to its catalogue of industrial films) two new sections, one dealing with automation, and one with the gas industry. These sections are included in its main catalogue dealing with all other films available on loan from its library, as well as from its branch libraries in Scotland and in Wales.

In March 1956 the Soviet Minister of Coal Industry suggested to the British Government an exchange of technical visits. A report by the British team has now been published: "The Coal Industry of the U.S.S.R", National Coal Board, London, price 8*s.* post free. It includes chapters on Organisation, Production, Planning, Underground Mechanisation, Engineering, Research, Development of Machines, Wages, Health, and Welfare, and Mining Education and Training.

H.M.S.O. Bulletin No. 164 of the Ministry of Agriculture, Fisheries and Food is on "Hop Growing and Drying" and costs 5*s.* The cost of establishing and growing hops is probably higher than for any other crop in Britain. To achieve maximum crops at minimum cost the grower needs all the knowledge he can get. This Bulletin should therefore fill an important need.

A small and somewhat inconclusive booklet on "Britain's Economic Problems and Policies" has been published by the Federation of British Industries at a cost of 3*s.* It seems a rather pathetic little nibble into an enormous problem calling for boldness and foresight.

The Report of the National Physical Laboratory for 1956 is published from H.M.S.O. at 5*s.* net. It summarises work on missile flight, the full-scale automatic computing engine ACE, data-handling equipment, developments in pneumatic gauging, and the effects of structural roughness on ships' hulls.

The Origin of Life on the Earth

A. I. OPARIN

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MANUAL OF MICROBIOLOGICAL METHODS

prepared by the Society of American Bacteriologists
edited by H. J. CONN and M. W. JENNISON

This manual has been prepared by the Committee on Bacteriological Technic of the Society of American Bacteriologists, which itself published the first four editions. It collects in one volume all the accepted methods used in the study of pure cultures of bacteria and other microbes. Research workers and students in bacteriology, microbiology and biology will find this a useful reference book for laboratory work. Many of the methods described here can be found only in scattered articles; examples of these are the procedures used for preserving stock cultures and the methods employed in microbial biochemistry. Techniques for determining morphological and biochemical characteristics for identification are especially fully covered.

December 1957 ***about 37s 6d***

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FAR AND NEAR

Automatic Assembly of Electrical Circuits

An automatic assembly machine which takes orders from itself was announced at the end of last month by IBM Corporation in New York. The new device is used to fasten resistors, capacitors, diodes, and the like—automatically—on to printed circuit panels before they are inserted into computers and other electronic equipment. But the new IBM machine goes a big step further. When a change in the layout and componentry of a panel is called for, gone is the old manual resetting job. Instead, the machine gets instructions from IBM cards and then automatically resets itself for the new assignment.

The new device, the Programmed Component Assembly System, was developed and built by manufacturing engineers at IBM's Poughkeepsie (U.S.) plant and is now hard at work assembling wiring panels for the Company's data processing equipment. IBM engineers say assembly speed is more than ten times faster than by manual methods, and a more uniform product is obtained.

Planetarium Comes to London

The optical components of the planetarium which is to be erected at Madame Tussaud's site near Baker Street have now arrived in London. A full article on the planetarium appeared in DISCOVERY in December 1956 on page 507. Inevitably, some months must elapse between the arrival of the complicated optical equipment and its formal opening to the public, and this is now expected to take place at the end of January. Perhaps one might add that it is appropriate that the planetarium should be opened in London during the International Geophysical Year.

New Institute of Scientific Information

An institute of scientific information has recently been opened in Peking to keep Chinese scientists informed on the latest research at home and abroad. They plan to publish a news sheet and to translate abstracts. They will also produce a journal, *Science News*, with information on conferences, books, and recent discoveries.

Any information from scientists in other countries will be gratefully received. Material should be sent to: The Institute of Scientific Information, Chinese Academy of Sciences, 117 Chao Yang Men, Peking.

Pre-Examination Strain

Dr Nicolas Malleson, physician-in-charge of the Student Health Association, University College, London, has written an interesting article in the *British Medical Journal* for September 7, 1957, on pre-examination strain. Every year, he says, the physician at a university health centre will be called upon to treat a substantial number of students suffering from nervous strain in the period before and during major examinations.

The main subjective symptoms are usually those of anxiety. Insomnia, tension, obsessional thinking, tearfulness, bouts of depression, somatic conversion symptoms, and particularly headache are the principal complaints. The fear felt by the student is two-handed. There is a fear of failure, and there is a fear of the examination itself. Usually they go hand in hand, but sometimes they are quite distinct. Students who know they have first-rate ability can be troubled almost as severely as poor students with only an outside chance; they fear the examination, not its outcome. It is perhaps true that the worst cases are usually among the weaker students, but exceptions are very numerous.

Dr Malleson thinks that to give confidence it is essential to maintain contact with the student right up to and over his examination period. It is only by a close and repeated contact that the student can come to feel that the doctor is standing with him.

All the students Dr Malleson and his colleagues have treated for pre-examination strain at the Student Health Centre have a pass rate very much the same as the college average: and, seeing they are the ones who suffer difficulties, the work seems well worth while.

Housing Experiment in Berlin

The problem of providing well-designed, low-cost houses and apartments for city-dwellers is common to countries all over the world. Solutions proposed by a number of internationally known architects, at an International Exhibition of Architecture in West Berlin, are exciting considerable interest.

The exhibition forms an experimental housing project laid out in a 44-acre park south of the Tiergarten, and when finished it will provide 1160 permanent homes for Berliners. The apartment blocks and houses, ranging from 17-story skyscrapers to single-story buildings, have been designed by architects from the German Federal Republic and from fourteen other countries, whose names include Gropius and Mies van der Rohe from the United States, Aalto from Finland, Jaenecke and Samuelson from Sweden, and Niemeyer from Brazil.

The "Dip. Tech." and Production

The Department of Industrial Engineering of the Loughborough College of Technology announces that the National Council for Technological Awards has recognised the first four years of their five-year sandwich course as leading to the Diploma in Technology (Dip. Tech. (Eng.)) in Production Engineering.

This course in pure Production Engineering is the first and, at the time of writing, the only one of its kind to be so recognised. It is intended to prepare student-apprentices for posts of responsibility, as production technologists or in management, in the metal-working industries. The subjects of the fourth-year (Dip. Tech.) examination are Industrial Metallurgy (including Plasticity, Molten Metal, and Welding); Theory of Machine Tools; Tool Design; Metrology; Work Study; Applied Statistics and Operational Research; Industrial Psychology; Industrial and Commercial Law. The course continues into a fifth year for the award of Associate of Loughborough College (A.L.C.), when the subjects of examination are Work Study; Personnel Management; Financial Management; Higher Business Control; Factory Management; Product Development, Design, and Distribution; Synthetic Materials; Technology of Automation.

Under the sandwich plan students spend six months each year in college and six months working as industrial apprentices. A number of nationally known companies operate student-apprenticeship schemes in connexion with these courses and are prepared to receive applications from suitably qualified youths.

Further particulars may be obtained from the Department of Industrial Engineering, Loughborough College of Technology, Loughborough, Leicestershire.

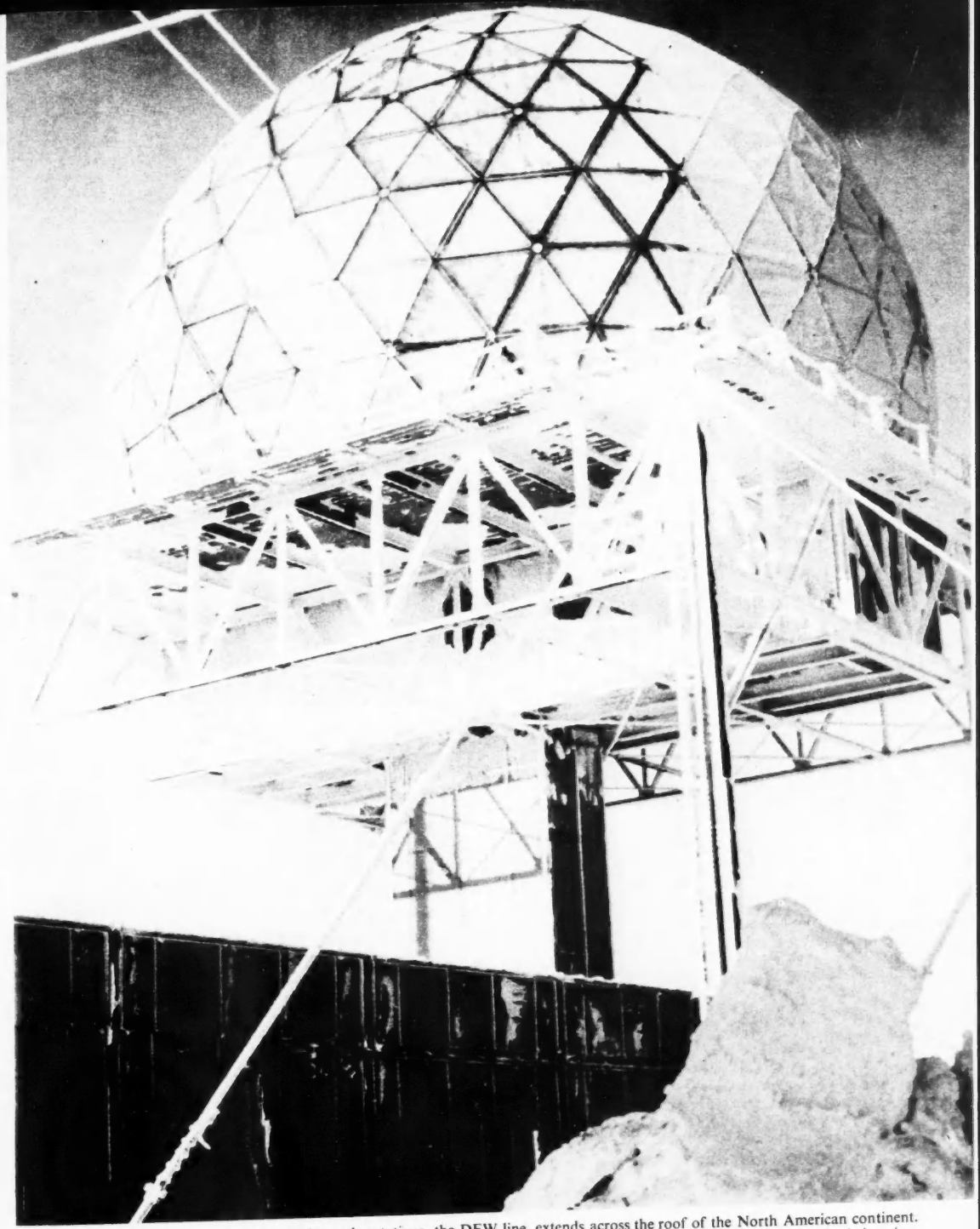
Hearing Without Ears

According to Stephen Coulter, writing in *The Sunday Times*, two French doctors have succeeded in overcoming total deafness. They have made a man hear through the nerve-system, with sounds by-passing the ears. The doctors are Dr Charles Eyriès and Dr André Djourno.

A patient had become stone-deaf. The inner ears were so destroyed that surgical repair was impossible. Dr Eyriès knew of work done by Dr Djourno, who had perfected a method of obtaining muscular responses from a rabbit by exciting a particular nerve by electromagnetic remote control.

With Dr Djourno, Dr Eyriès applied the method to the deaf patient. He introduced a tiny induction coil into the man's temporal muscle, fastened it to part of the aural nerve, and left one negative wire in the muscle. The surgeons then wired a low-frequency generator, which would transform sound-waves into electric impulses of the same frequency, to an induction coil placed outside the man's temple, opposite the coil buried in his head. Thus an electromagnetic field was set up between the two coils.

The patient is now able to hear



A 3000-mile chain of early warning radar stations, the DEW line, extends across the roof of the North American continent. The heart of a DEW Line Station is the huge Air Search radar antenna, which rotates inside a protecting plastic housing. Although the antenna is entirely surrounded by this housing, the electric beams going out from it and the echo impulses returning are able to pass unaffected through the Dome's "skin".

sounds through his nerve-branch. He understands a certain number of words and can repeat them.

Mineral Deposits in Pakistan

Recent surveys made by geologists in the Quetta and Kalat regions of West Pakistan have revealed deposits of chromite, high-quality iron ore, copper, manganese ore, and indications of gold in the Chagai district, on the borders of Afghanistan. The geologists are carrying out an extensive survey for the Pakistani Government to find mineral resources for the country's growing industries. They have been assisted in their work by scientists from the Geophysical Institute in Quetta, established by the Government with assistance from UNESCO experts under the United Nations programme of technical assistance.

Other minerals discovered include vermiculite, used as an insulator; fluorite; barytes, a heavy mineral used in drilling; and asbestos. These discoveries have yet to be prospected to determine their commercial value.

During their operations, the Pakistani geologists have used aerial photographs taken by the Photographic Survey Corporation of Canada, under the Colombo Plan. The photos make it possible to distinguish various rock formations and define possible mineralised zones. Maps now being prepared in Canada from the photographs will provide a basis for planning future surveys.

Television for Traffic Control

Britain's first permanent television installation for traffic control is to be set up in the Market Square at Durham. The Minister of Transport and Civil Aviation has informed the Durham County Council that he approves of the television scheme and will make a contribution towards its cost. At present a policeman stationed in the Market Square is required to control traffic which he cannot see. The television cameras will transmit a picture of the actual traffic conditions to a screen in the control box and will help the constable to reduce traffic delays to a minimum. He will also see the kind of traffic waiting and make allowance for heavy, slow-moving vehicles. This new method of traffic control was tried out successfully in Durham in August 1956 and is now to be installed permanently.

Rainmaking Research

The Minister in Charge of Australia's CSIRO, Mr R. G. Casey, has announced that the Government will purchase two new twin-engined aircraft so that its programme of experimental rainmaking can be considerably extended. Mr Casey referred to the difficulty of proving that the seeding of clouds could increase rainfall over an area. During the past two winters rainfall over the Snowy Mountains area had apparently been increased by approximately 20% but this experiment would need to be continued for another two to three years in order to put the matter beyond question.

One of the new aircraft will be used in a long-term experiment in two areas of the Mount Lofty Ranges north of Adelaide. The second aircraft will probably attempt rainmaking on the western slopes of the Northern Tablelands of New South Wales.

Arctic Waters Warmer

The temperature of the Arctic Ocean has risen 2° C to a depth of 300 feet around Jan Mayen Island, 400 miles north-east of Iceland, according to a report from the Norwegian fishery research ship *Gosars*. The ship's crew also reported that the belt of drift ice off the east coast of Greenland is only a quarter of its normal width, and a large area of sea between Jan Mayen and Bear Island has become ice-free.

The rise in temperature has enabled new fishing banks to be charted by the *Gosars* during its voyage of investigation.

Gravity Survey on Sea-bed

A geophysical survey, unique in the history of surveying in Australia, has begun in Port Phillip Bay, Victoria. The Bureau of Mineral Resources of the Department of National Development is using a recently purchased underwater gravimeter to make measurements of the force of gravity on the bay's sea-bed.

The instrument, which was purchased from the United States at a cost of £A15,000, is enclosed in a massive steel bell which is lowered from a ship to the sea floor. It is levelled by electronic means and read by remote control. The meter is extremely sensitive and will measure small differences in the force of gravity with the astonishing accuracy of one part in a hundred million. The instrument can take measurements in water to a depth of 600 feet.

Mexico Exploits Geyser Energy

Geothermic energy may soon be supplying half the power requirements of Mexico City and its suburbs, according to plans now being developed by the Federal Electric Commission in Mexico.

The country is well provided with potential geysers, especially in the central plateau extending almost from the Mexican Gulf to the Pacific Ocean, the area in which most electricity is consumed and where most important industrial installations are located.

Three wells have already been sunk in Hidalgo State, north of Mexico City, and the first geyser which gushed up last year is estimated to have a power capacity of 25,000 kW. The Commission intends to bore some ten to twelve wells capable of producing at least 250,000 kW. Production savings through the use of geothermic power are expected to run to 15 million pesos ($1,200,000) annually per well.

Errata

The cover picture of the October issue was attributed to the Expéditions Polaires Françaises Greenland Expedition. In fact it showed a French Snocat on the trek to set up the Magnetic South Pole Station in Terre Adélie, Antarctica.

Dr D. R. Newth wishes to emphasise that the trout photographed on page 409 of the October issue are incorrectly called *mutations*, whereas they should be called *monstrosities*.

Classified Advertisements

OFFICIAL APPOINTMENTS

DIRECTOR OF FUEL AND PROCESS RESEARCH: DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. The Civil Service Commissioners invite applications for this pensionable post at the new Research Station shortly to be built at Stevenage, in ultimate replacement of the present Fuel Research Station, Greenwich. Age at least 30 on October 1, 1957. At the new Station, the research programme will include:

(i) work on problems of fuel and atmospheric pollution, which will include, but will not be confined to, certain projects to be transferred from the existing Fuel Research Station, Greenwich;

(ii) some aspects of mineral processing;

(iii) other projects (including projects involving process development) which can be appropriately undertaken with the staff and facilities to be provided.

The staff (all grades) at the new Station will initially number about 300.

Candidates should preferably be physical scientists with a knowledge of the problems of chemical engineering. They must have high qualifications, but a candidate without high formal qualifications may be considered.

All candidates must have had a wide experience in the organisation and management of scientific research, including research leading to and involving development to intermediate scale.

They should also have had experience of administration and have the ability to lead and inspire staff over a wide field of science.

The salary at Stevenage is £3300 per annum for a man; for a woman it is at present somewhat less.

Further particulars and application forms may be obtained from the Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4775/57. Completed application forms must be returned by November 22, 1957.

PHYSIOLOGICAL LABORATORY SUPERINTENDENT (MALE) required by NIGERIA NORTHERN REGION Medical Department for tour of 12/24 months in first instance, either (*a*) with prospect of pensionable employment with salary scale (including Inducement Addition) £750 rising to £1284 a year, or (*b*) on temporary terms with salary scale (including Inducement Addition) £810 rising to £1386 a year plus gratuity at rate of £100/£150 a year. Commencing salary according to experience. Clothing allowance £45. Free passages for officer and wife. Assistance towards children's passages and maintenance grant up to £288 annually. Liberal leave on full salary. Candidates must have had experience in laboratories of a teaching institution with specialised knowledge of physiology and biology, and be able to maintain physiological apparatus. Duties include assistance in laboratory work to trainee pharmacists.

Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3/44413/DI.

ASSISTANTS (SCIENTIFIC). The Civil Service Commissioners invite applications for pensionable posts.

Age at least 17½ and under 26 years of age on January 1, 1957, with extension for regular service in H.M. Forces, but candidates over 26 with specialised experience may be admitted.

Candidates must produce evidence of having reached a prescribed standard of education, particularly in a science or mathematical subject. At least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:

(*i*) Engineering and physical sciences.
(*ii*) Chemistry, bio-chemistry, and metallurgy.
(*iii*) Biological Sciences.
(*iv*) General (including geology, meteorology, general work ranging over two or more groups (*i*) to (*iii*) and highly skilled work in laboratory crafts such as glass-blowing).

Starting pay £355 (at 18) up to £485 (women £454) at 25. Men's scale maximum £665. Women's scale being raised to reach equality with men's by 1961. Somewhat less in provinces. Opportunities for promotion and for further education. Five-day week, generally.

Further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S59/57.

Interview Boards sit at intervals, as required. Early application is advised.

CONTROL OFFICER required by NORTHERN NIGERIA GOVERNMENT Medical Department for one tour 12/24 months in first instance. Salary scale (including inducement addition) £810 rising to £1716 a year. Gratuity at rate £100/£150 a year. Commencing salary according to experience. Clothing and touring equipment allowance £85. Free passages for officer and wife. Assistance towards children's passages and grant up to £288 annually. Liberal leave on full salary. Candidates, preferably single, should have good general education and agricultural training or knowledge of surveying, mapping, entomology or botany.

Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3A/43728/DI.

SPECIALIST SUPERINTENDENT required by GOVERNMENT OF NORTHERN REGION NIGERIA Agricultural Department for one tour of 12/24 months in first instance either (*a*) with prospect of pensionable employment-salary scale (including Inducement Addition) £750 rising to £1554 a year, or (*b*) on temporary terms—salary scale (including Inducement Addition) £810 rising to £1716 a year plus gratuity at rate of £100/£150 a year. Commencing salary according to experience. Clothing allowance £45. Free passages for officer and wife. Assistance towards children's passages and grant up to £288 annually. Liberal leave on full salary. Candidates, preferably under 35, must be highly trained in laboratory techniques of either Plant Pathology or Entomology and should possess Diploma of INSTITUTE OF SCIENCE TECHNOLOGY or similar qualification or experience.

Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3A/35303/DI.

MINISTRY OF LABOUR AND NATIONAL SERVICE. H.M. INSPECTORS OF FACTORIES (CLASS II). The Civil Service Commissioners invite applications from men and women for pensionable posts in the Factory Inspectorate, which is being expanded. Age at least 21 and normally under 30 on June 1st in the year of application. Extension of the upper age limit for regular service in H.M. Forces and for candidates with exceptional qualifications. Starting salary £545 (at age 21) up to £710 at 26 or over. Scale maximum £980. Somewhat lower outside London. A special increment of £25, within the scale, is granted after satisfactory probation Higher posts filled by promotion from Class II. The salaries are now subject to an increase of the order of 5 per cent.

Duties include the enforcement of the provisions of the Factories Acts and Regulations affecting the safety, health and welfare of work-people and extend to all manufacturing industries and to certain other places, including Docks, Works of Engineering Construction and Building Operations.

Candidates should normally have a university degree (which may be in science or in arts subjects) or have technical qualifications of comparable standard (e.g. A.M.I.Mech.E.). Experience in works or other practical spheres is an advantage.

Candidates without degrees or similar technical qualifications will be considered if they have had extensive works or other practical industrial experience (especially in responsible positions) and if they have good general or technical qualifications.

Application may be made at any time, and so long as there are vacancies suitable candidates will be interviewed.

Particulars from Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 280.

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Candidates must have (or obtain in 1957) 1st or 2nd Class Honours in Physics, Organic or Inorganic Chemistry, Mechanical or Electrical Engineering or in Mathematics, or an equivalent qualification, or have achieved a professional qualification, e.g. A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C. For a limited number of vacancies candidates with 1st or 2nd Class Honours degrees in other subjects—scientific or otherwise—will be considered. Exceptionally, candidates otherwise qualified by high professional attainments will be considered.

Starting pay for five-day week of 42 hours in London between £605 and £1120 (men), according to post-graduate (or equivalent) experience and National Service. Maximum of scale £1345. This salary scale is being increased by approximately 5%. Women's pay above £605 slightly lower but is being raised to reach equality with men's in 1961. Good prospects of promotion to Senior Examiner rising to £2000 (under review) and reasonable expectation of further promotion to Principal Examiner.

Application form and further particulars from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S128/57 and stating date of birth.

Interview Boards will sit at intervals, as required. Early application is advised.

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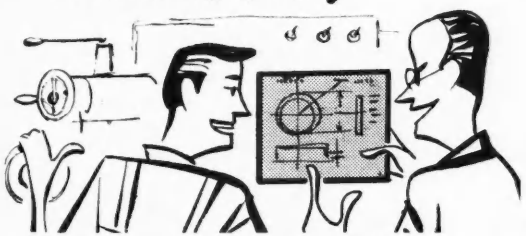

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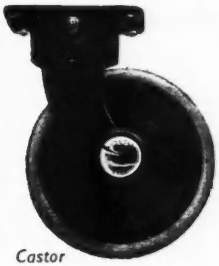

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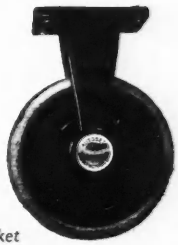

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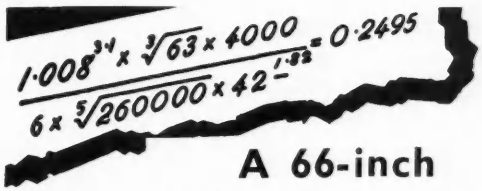

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.....

Rosy Future

From his barrow, stacked with pyramids of fruit, the barrow boy picks a rosy apple. Polishing it on his sleeve, he shouts, " Oranges, apples, pears — they're LUVERLY ! " It can't always be true, but the day when perfect fruit is assured has certainly been brought nearer by the development, in I.C.I. laboratories, of ' Tetram '. This new compound is the first complete answer to red spider and the other pests that plague the world's cotton crops and fruit such as apples, pears, oranges and lemons.

The potential benefits of ' Tetram ' are enormous for, in the United Kingdom alone, there are 82,000 acres of apple trees exposed to the ravages of red spider. World-wide development work has enabled I.C.I. to perfect ' Tetram ', the most powerful, persistent and versatile acaricide that red spider and its co-pests, mites and scale insects, have had the misfortune to meet — they never live to repeat the experience.

Thus, and in a thousand kindred ways, I.C.I.'s research and production are serving the Nation.

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